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# The Effect of Firm Efficiency on Firm Value of Public Companies in Indonesia with IT Investments and The Covid-19 Pandemic as Moderating Variables

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***Abstract:***

*The purpose of the establishment of the company is to maximize wealth for shareholders. The increase in shareholder and company wealth is represented by firm value. The higher firm value, the higher the wealth of shareholders. The increase in shareholder wealth through increasing firm value is influenced by several factors, including how efficient the company in managing its resources. The use of information technology (IT) is believed to increase firm efficiency. The rapid increase in the total confirmed cases, the Covid-19 pandemic affected not only health conditions, but also gradually led to a global crisis that affected almost every country around the world. In the midst of increasing uncertainty during the Covid-19 pandemic, firm efficiency is needed by companies to survive. This study aims to determine the effect of firm efficiency on firm value. This research was conducted on companies listed on the IDX for the period 2017-2021. This study use moderating variables in the form of Information Technology (IT) investment and the Covid-19 pandemic. It also uses control variables consisting of company size, financial leverage, and cash holding. The results of this study showed that IT investment has a significant negative effect on firm efficiency. The Covid-19 pandemic has a significant negative effect on firm efficiency. Firm efficiency has a positive effect on firm value. This study also finds that IT investment weakens the relationship between firm efficiency and firm value, and the Covid-19 pandemic strengthens the relationship between firm efficiency and firm value.*

***Keywords:*** *firm efficiency, firm value, information technology investment, pandemic Covid-19*

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## 1. Introduction

The purpose of the establishment of the company is to maximize wealth for shareholders by increasing the value of the company. Viewed from the perspective of investors, the value of the company is usually associated with the market price of the stock. High stock market prices will increase the returns received by investors. A high return is a good sign for potential investors to participate in investing in the company. Investors will be attracted to companies that provide prosperity to shareholders.

The increase in shareholder prosperity through increasing the firm value is influenced by several factors, including how efficient the company is. There is a relationship between firm efficiency and firm value, but some previous studies have provided two contrasting relationships, namely negative relationships and positive relationships. This relationship is negative because efficient companies tend to use large amounts of debt. The use of large debt will burden the company with high interest costs. This will have an impact on investors' profit levels getting smaller. So the company's ability to provide returns will be low, and the company will be rated low by investors. On the other hand, the positive relationship between company efficiency and company value occurs because more efficient companies have a stronger position in the market because they have economies of scale. This makes more efficient companies less vulnerable to industry shocks and competition, so they can earn higher profits. In addition, companies that use resources efficiently have more certain cash flows and a much lower risk of corporate default. In this way the company will be valued higher by investors (Demsetz, 1973; Nguyen and Swanson, 2009; Frijns, Margaritis and Psillaki, 2012; Gaganis, Hasan and Pasiouras, 2013; Pham, 2018; Nguyen *et al.*, 2019; Chuan'Chewie'Ang, Lam and Wei, 2020; Harahap, Septiani and Endri, 2020; Neukirchen *et al.*, 2022). In the context of the Indonesian state itself, the negative relationship between firm efficiency and firm value has a weak position. Research (Hubbansyah et al., 2021) found that the higher level of debt to companies in Indonesia does not have a positive impact on firm efficiency. In addition, this study shows that the level of debt to Indonesian companies is still below 50% of their total assets, this shows that companies in Indonesia are not too high in debt use. Therefore, this study chose a positive direction for the relationship of firm efficiency to firm value.

The use of information technology (IT) is believed to improve firm efficiency. Because internally, IT can reduce the costs of running a business, improve the quality and speed of operations, eliminate repetitive business processes, and increase business flexibility. In addition, externally, IT can increase competitive advantage and improve position in the market through improving customer satisfaction (Khallaf, 2012; Gill, Kang and Amiraslany, 2023). The usefulness of IT is believed to be able to improve several aspects of this company, encouraging companies to invest in IT. Companies that decide to invest not only expect profits, but must also be prepared to bear all the consequences that may arise from future risks. As the Indonesian economy improves, companies that are able to adapt, avoid bankruptcy and excel in competition will

become more competitive. Companies must maintain and improve performance in an effort to maintain company continuity and implement efficient and effective strategic policies for companies to invest in information technology products and services such as hardware, software, telecommunications training and consulting (Gunawan and Serlyna, 2018). Previous research has found a positive influence of IT investment on firm efficiency (Novotná *et al.*, 2021). It can increase a company's profitability. With increasing profitability, actual stock returns are getting higher, a good sign for investors, and firm value will increase (Berggrun, Cardona and Lizarzaburu, 2020; Hosea, Kindangen and Worang, 2020; Sholichah *et al.*, 2021).

Amid increasing uncertainty during the COVID-19 pandemic, efficiency is needed by companies to survive. At the same time, the spread of the COVID-19 pandemic has prompted rapid changes in financial markets and global capital markets by affecting the performance of the stock market (He *et al.*, 2020; Liu *et al.*, 2020; Wu, Yang and Zhao, 2020). In theory, the market value of stocks is influenced by the expected cash flow. The rapid spread of the COVID-19 pandemic, the growing death rate, and unpredictable government policies make investors' future cash flow even more uncertain. With increasing uncertainty for investors, it will affect the stock price and ultimately lower firm value.

Research in proving the effect of firm efficiency on firm value has been carried out in many countries, but all studies are conducted in developed countries, no research has been conducted in developing countries. In addition, research conducted during the COVID-19 pandemic is still limited to research conducted by (Neukirchen *et al.*, 2022). Therefore, researchers are interested in conducting this research to obtain empirical evidence on whether firm efficiency has a negative/positive effect on the value of public companies in Indonesia during the COVID-19 pandemic. Based on previous research, due to inconsistencies in results, in this study moderating variable was added in the form of IT investment and the Covid-19 pandemic. In addition, this study complements previous research by using 2 (two) firm value proxies and 2 (two) firm efficiency proxies. The purpose of this study is to add to the growing literature on corporate efficiency on corporate value in the context of developing countries such as Indonesia. Based on the phenomenon described above, the purpose of this study is to determine the effect of firm efficiency on firm value moderated by IT investment and the Covid-19 pandemic.

## 2. Theoretical Background

**Signaling Theory**

Signaling theory is a tool used by companies aimed at providing guidance to investors on how management views a company's prospects. Since management essentially has more information about the company than outside parties, management has an obligation to inform investors about the health of the company by signaling that the company is in good shape. The information a company publishes is important because

it influences investors' investment decisions. In essence, this information provides information, indications, or explanations about past, present, and future conditions for the company's business continuity (Brigham and Houston, 2019).

The relationship between signal theory and firm efficiency is that managers will give signals to investors about the firm efficiency, this will be responded to by investors. Companies that are more efficient will respond positively by investors than inefficient companies, so investors will give higher value to the company. Good company performance will be considered good by the market so that it will increase demand for shares, this is followed by an increase in share prices. This increase in share prices will affect capital gains as a component of actual share returns. This is because companies that are more efficient are better at using funds, and have a lower risk of default. In addition, company inefficiency is one of the risks that cannot be diversified away so it is unlikely that this risk can be fully captured by the market. (Frijns, Margaritis and Psillaki, 2012; Hanifah, 2019; Harlan and Wijaya, 2022).

**The Efficient Structure Theory**

The Effficient Structure Theory (The ES) is a theory first developed by Demsetz in 1973. This theory states that under the pressure of market competition, efficient companies will win the competition, gain greater market share and greater profitability, and grow stronger. This theory confirms that high profitability comes from high efficiency and low cost. The higher the profitability, the higher the actual stock return that will be received by investors (Berggrun, Cardona and Lizarzaburu, 2020; Hosea, Kindangen and Worang, 2020). In addition, high profitability is a good signal for investors because the company can provide returns and can attract investors to buy shares of the company so that the stock price will increase, which will eventually increase firm value (Sholichah *et al.*, 2021).

Berger (1995) tested The ES Theory by looking at the effect of firm efficiency on profitability and found that more efficient companies would become larger companies and the market would become more concentrated. So the company's income is relatively high, costs are low and profitability is high. There are two reasons explained by Berger (1995) in his research, namely 1) Companies that excel in production and technology management have lower costs and higher profits. So this company has a large market share. 2) Companies tend to have fairly good management and technical equations, but few can produce more efficiently than others, resulting in lower unit costs and higher profitability. The higher the profitability, the higher the firm value.

Homma et al., (2014) conducted a new test related to The ES theory, namely by testing the relationship between efficiency and company growth with a sample of banks in Japan. In their research it was found that banks that are more efficient will win the competition and grow larger.

**Information Technology (IT) Investment**

Previous research defines IT investment in the form of all costs incurred related to computer hardware (hardware), computer software (software), network facilities, IT pre-development costs, IT maintenance costs, IT training costs, and application costs (Khallaf, 2012; Stores *et al.*, 2018). From this definition, this study measures IT investment by summing the company's expenditure from IT-related Capital Expenditure and Operating Expenditure.

The use of information technology (IT) is believed to increase firm efficiency. Because internally, IT can lower the cost of running a business, improve the quality and speed of operations, eliminate repetitive business processes, and increase business flexibility. In addition, externally, IT can increase competitive advantage and improve position in the market through improved customer satisfaction (Khallaf, 2012; Gill *et al.*, 2023).

Although the usefulness of IT can already be proven by previous research, such as increasing efficiency (Novotná *et al.*, 2021; Hilhorst *et al.*, 2022), increased profitability (Mithas *et al.*, 2012; Kossaï and Piget, 2014), improved performance (Ji, Yan and Shi, 2022), increased processing speed and cost effectiveness (Matias and Hernandez, 2021), decreased costs (Raut *et al.*, 2017), and increased business opportunities through information transparency (Paliwal, Chandra and Sharma, 2020). In contrast to (Brynjolfsson, 1993) research which found a decrease in productivity as a result of IT investment or often referred to as the "Productivity Paradox". In his research, (Brynjolfsson, 1993) suggests that this is due to the absence of restructuring and cost savings.

In addition to the Productivity Paradox issue, time is an important contextual factor in IT investments. It takes time for companies to realize the business benefits of IT investment because it takes quite a lot of time for the company to develop its ability to implement IT, so that then feel the benefits of IT investment (Campbell and Cocco, 2015). According to (Teekasap, 2017), in the early era, a superior IT infrastructure can create good performance for companies because it becomes a differentiation for competitors. However, some time later competitors will realize the benefits of IT investment so they invest more in IT. Therefore, in the long run, IT investment does not drive company performance. Similar conclusions are also confirmed by research by (Ji, Yan and Shi, 2022) where there is a "time lag effect" of IT investment on company performance and the research found that it takes an average of about 3 (three) to 4 (four) years after the investment year for companies to feel the benefits of IT investment.

**Hypotheses Development**

Several previous studies have found a positive influence of IT investment on company performance through increased productivity (Lim *et al.*, 2017; Kotni, 2023), increased profitability (Robba *et al.*, 2019), increased speed of service (Matias and Hernandez, 2021), reduced distribution costs (Hutabarat and Pratiwi, 2022), cost

reduction and competitive advantage (Raut *et al.*, 2017), and maximize business opportunities through increased transparency (Paliwal, Chandra and Sharma, 2020).

With the development of IT, changes in the work environment occur. The role of IT becomes important in strengthening the company's competitiveness. Therefore, companies continue to increase IT investments. (Gartner, 2022) states that global IT investment is estimated at US$ 4.4 million in 2022, this is an increase of 4% from 2021. Accelerated IT investment is needed because companies recognize the importance of flexibility and agility in the face of uncertainty.

(Novotná *et al.*, 2021) examined the effect of IT investments on the efficiency of manufacturing companies in the Czech Republic. The positive effect of IT investment on firm efficiency is that the use of IT can increase workforce productivity. (Hilhorst *et al.*, 2022) also found the positive influence of IT investment on efficiency in the public sector in the Netherlands. The amount of IT investment determines the amount of efficiency achieved. The greater the IT investment, the greater the efficiency the public sector achieves. This is because the use of IT can increase efficiency in two ways, first, business process automation that can increase productivity and information quality. This automation can reduce errors, process large amounts of data, and reduce task processing time so that the information produced is of higher quality. Second, IT can make the work process more transparent and standardized.
Based on some of the previous studies above, the first hypothesis of this study is:
**H1: IT investment has a positive effect on firm efficiency.**

The rapid increase in total confirmed cases and the COVID-19 pandemic have affected not only health conditions but also gradually caused a global crisis affectingalmost every country around the world (Shaw and Rakshit, 2021). The spread of the COVID-19 pandemic has forced various countries around the world to close and stopeconomic processes (Lockdown) and carry out social distancing strategies that have resulted in massive disruption to business activities and the global economy. The crisis caused by the COVID-19 pandemic has had a significant impact on almost all countries, with a negative impact on the economies of these countries (Shaw and Rakshit, 2021).

Research (Kirkulak and Erdem, 2014) provides information on one of the negative impacts of the financial crisis in Turkey. His research compared the state of firm efficiency before and during the 2001 financial crisis in Turkey. The results show that there was a decline in efficiency in all non-financial companies listed on the Istanbul Stock Exchange during the 2001 financial crisis. This happened because the financial crisis caused idle capacity, which led to low production efficiency and decreased ability to convert production into sales.

The impact of the crisis was also elaborated by (Gulati and Kumar, 2016) who examined the impact of the 2007-2009 global financial crisis on the efficiency of banks in India using a comparison of efficiency scores from the DEA. (Gulati and

Kumar, 2016) found that the global financial crisis of 2007-2009 had led to a decline in efficiency in all banks in India. Even after the crisis period has passed, efficiency declines continue, especially in Private Banks and Foreign Banks, in contrast to Government Banks whose efficiency recovers faster (Goswami, 2022). (Martínez-Campillo and Fernández-Santos, 2020) also added that the crisis has caused inefficiencies in the Education sector in Southern Europe, namely in Greece, Italy, Portugal, and Spain.

In addition to the financial crisis in 2001 and 2007-2009, the crisis caused by the COVID-19 pandemic also hurt the company's efficiency. (Zheng and Zhang, 2021) found that the COVID-19 pandemic reduced efficiency in microfinance companies in 11 countries, one of which was in Indonesia. (Fernandes, de Araujo and Tabak, 2021) also examined the effects of the crisis caused by the COVID-19 pandemic on all sectors of public companies listed on the China Stock Exchange. The results of his research show that the COVID-19 pandemic caused inefficiencies in almost all sectors of public companies listed on the China Stock Exchange. This effect depends on the sector being analyzed so the resulting inefficiencies are not homogeneous. It also shows that it is important to assess that different sectors respond differently to global shocks.
Based on some of the previous studies above, the second hypothesis of this study is:
**H2: Pandemi Covid-19 berpengaruh negatif terhadap efisiensi perusahaan**

Theoretically, there are two points of view about the relationship between firm efficiency and firm value, namely 1) firm efficiency negatively affects firm value, and 2) firm efficiency positively affects firm value. The efficiency of the company has a positive effect on the value of the company based on signal theory and The ES theory. Based on signal theory, managers will give signals to investors about the efficiency of the company, this will be responded to by investors. More efficient companies will be responded positively by investors than inefficient companies, so investors will value the company more. This is because more efficient companies become better at using funds, and have a lower risk of default. In addition, company inefficiencies are one of the risks that cannot be diversified so it is unlikely that this risk can be fully captured by the market (Frijns, Margaritis and Psillaki, 2012). In line with The ES theory which states that higher profitability comes from high efficiency and low costs. The higher the profitability, the actual stock return that will be received by investors is also higher (Berggrun, Cardona and Lizarzaburu, 2020; Hosea, Kindangen and Worang, 2020). This is because the company will be able to provide dividends to investors after fulfilling their obligations such as taxes and interest payments (Reddy and Santosh, 2021). In addition, high profitability will ultimately increase the value of the company (Sholichah *et al.*, 2021).

The efficiency of the company negatively affects the value of the company. This negative relationship occurs because efficient companies tend to use large amounts of debt. The use of large debts will burden the company with high-interest expenses. This will have an impact on the level of profit of investors who are getting smaller. So the

company's ability to provide returns will be low, and the company will be undervalued by investors (Demsetz, 1973; Nguyen and Swanson, 2009; Pham, 2018; Nguyen *et al.*, 2019; Chuan'Chewie'Ang, Lam and Wei, 2020; Harahap, Septiani and Endri, 2020).

(Nguyen and Swanson, 2009) examined the effect of corporate characteristics and firm efficiency on stock returns for the period 1985-2003. The results of this study show that there is a negative relationship between firm efficiency and stock returns. (Nguyen *et al.*, 2019) conducted testing as a development of (Nguyen and Swanson, 2009) research by examining the effect of firm efficiency and industry concentration on stock returns. The results of this study are in line with the research of (Nguyen andSwanson, 2009) which found that there is a negative relationship between firm efficiency and stock returns. (Pham, 2018) conducted the same test as (Nguyen *et al.*, 2019) by examining the effect of firm efficiency and industry concentration on stockreturns with samples from companies listed on the Australian Stock Exchange (ASX)in 1995-2013. The results of this study show that there is a negative relationship between firm efficiency and stock returns. (Chuan'Chewie'Ang, Lam and Wei, 2020)examined the effect of firm efficiency on stock returns from 1972 to 2015. (Chuan'Chewie'Ang *et al.*, 2021) examined the effect of firm efficiency on stock returns in Australian companies from 1991-2019. Both studies showed similar results, although using different country samples. The result of this study is that there is a negative relationship between firm efficiency and stock return. Because the more efficient the company, it tends to use large amounts of debt. The use of large debts will burden the company with high-interest expenses. This will have an impact on thelevel of profit of investors who are getting smaller. So that the company's ability to provide returns will be low, and the company will be undervalued by investors (Harahap, 2021).

In contrast to the research of (Nguyen and Swanson, 2009; Pham, 2018; Nguyen *et al.*, 2019; Chuan'Chewie'Ang, Lam and Wei, 2020; Chuan'Chewie'Ang *et al.*, 2021), several studies have found that firm efficiency has a positive influence on firm value. (Frijns, Margaritis and Psillaki, 2012) tested the effect with a sample of companies from 1985 to 2003. (Frijns, Margaritis and Psillaki, 2012) revealed that more efficient companies will be responded positively by investors than inefficient companies, so investors will value companies higher.

(Gaganis, Hasan and Pasiouras, 2013) revealed that there was a positive relationship between firm efficiency and firm value in insurance companies in Australia in 2002-2008. (Gaganis, Hasan and Pasiouras, 2013) argue that firms that use resources more efficiently become more resilient during periods of crisis because the risk of corporate default is significantly lower. Therefore, these companies should be valued higher by investors.

Based on some of the previous studies above, the third hypothesis of this study is:
**H3: Firm efficiency affects firm values**

Various conveniences in supporting business processes as a benefit of using IT can have an impact on company profitability. Kossai and Piget (2014) found that the use of IT increases profitability in companies in Tunisia's electronics and electrical industries. In line with the study, Mithas et al., (2012) found that IT investment has a greater impact on company profits than investment in advertising or Development and Research. This happens because IT investment provides space for companies to be creative and innovate. Mithas et al., (2012) also explain that IT can be used to increase efficiency and reduce costs. In addition, IT can also be used to support sales growth through customer satisfaction and customer retention strategies. IT investments are more effective in increasing profitability through increased revenue than in reducing operational costs. The increase in company profitability will have an impact on the company's ability to provide returns to investors (Berggrun, Cardona and Lizarzaburu, 2020; Hosea, Kindangen and Worang, 2020). The higher the profitability of the company, the actual stock return that will be received by investors is higher, because the company will be able to provide dividends to investors after fulfilling its obligations such as taxes and interest payments (Reddy and Santosh, 2021). In addition, high profitability is a good signal for investors because the company can provide returns and attract investors to buy company shares so that the stock price will increase (Sholichah *et al.*, 2021).

Based on the above, the fourth hypothesis of this study is:
**H4: IT investment can strengthen the relationship between firm efficiency and firm value.**

The COVID-19 pandemic is a public health problem that has had a major impact on global financial markets for the first time (Ashraf, 2020; Albulescu, 2021). (Al-Awadhi *et al.*, 2020) found that the increasing number of infections and deaths due to the COVID-19 pandemic hurt stock returns for all Chinese companies. (Anh and Gan, 2020) assert that the increase in COVID-19 cases every day hurts stock returns in Vietnam as a result of lockdown policies. (Ashraf, 2020) investigated the impact of the pandemic on stock market performance in 64 countries and found an inverse relationship between the increase in confirmed cases and stock returns. (Alfaro *et al.*, 2020) found the negative impact of Covid-19 on stock returns in the United States. (Zhang, Hu and Ji, 2020) found negative consequences in the stock markets of ten countries that had the highest number of confirmed cases in March 2020. (He *et al.*, 2020; Liu *et al.*, 2020) evaluated the effect of COVID-19 on stock markets in several countries and found a negative relationship between the pandemic on stock returns.

(He *et al.*, 2020) also showed the effects of the spread of the COVID-19 pandemic among Asian, European, and American countries. The severe impact caused by the COVID-19 pandemic on the stock market has forced governments around the world to impose bans and restrictions to reduce the risk of market crashes, reduce volatility, and protect market stability (Kodress, 2020). Theoretically, stock value is correlated with future cash flows (Karami, Azimi and Ahmadi, 2021). The rapid transmission of the virus and death rates make economic activity and government policies

unpredictable, making investors' future cash flows highly uncertain. Growing uncertainty affects expected stock returns, actual stock returns, and current stock market values (Shaw and Rakshit, 2021).

The COVID-19 pandemic will reduce firm efficiency because the crisis can cause idle capacity, thus pushing production efficiency to be low and decreasing the ability to convert production into sales. This decrease in sales ability has an impact on decreasing the company's profitability so that the actual return provided by the company to investors will decrease. However, not many researchers have conducted research related to the influence of the COVID-19 pandemic which can weaken the relationship between firm efficiency and firm value. Based on the above, the fifth hypothesis of this study is:

**H5: The Covid-19 pandemic can weaken the relationship between firm efficiency and firm value.**

## 3. Methodology

**Sample and Population**

The authors determine sampling by establishing specific characteristics that are appropriate to the objectives of the study, namely:

1. Listed on the IDX during the period 2018 to 2021.
2. The company has active shares traded during the period from 2018 to 2021.
3. The company provides complete annual report data that is needed in the research period 2018-2021.

The 2018-2021 period was chosen for this research because 2018 and 2019 was Non-Pandemic Covid Period, will be compared with 2020 and 2021 that was Pandemic Covid Period.

**Table 3**. Sample Selection Procedure

| Sample Selection | Number of Companies |
|---|---|
| Company Listed on IDX for the period 2018-2021 | 787 |
| Reduced : Financial Industry | 108 |
| Reduced: Companies that do not have complete financial data | 400 |
| Reduced : Companies that do not disclose the amount of IT investment | 279 |
| Number of research samples | 153 |
| Number of years of research | 4 |
| Number of Model Observations | 612 |

**Firm Efficiency Measurement**

In this study the author used Firm Efficiency as the dependent variable (Hypothesis 1 and 2) and independent variable (Hypothesis 3, 4 and 5). In this research, firm efficiency is proxied by Income to Cost Ratio (ICR) and efficiency scores from the frontier approach (SFA/Stochastic Frontier Analysis). ICR is a measurement of firm efficiency using a traditional approach, while SFA is a measurement of firm efficiency

using a frontier approach. ICR is widely used to calculate a company's efficiency score, this ratio is used to compare income with operational costs, how efficient the company is in generating income using its operational costs. This ratio measurement can be formulated as follows:

$$Income\ to\ Cost\ Ratio\ (ICR) = \frac{Total\ \ Pendapatan}{Total\ B<aya>peras<onal}$$

Frontier approaches that are often used in measuring efficiency are SFA and DEA. DEA is widely used because of its ease and simplicity which can handle various outputs and inputs. But DEA assumes that all deviations from Frontier (the most efficient company) are due to inefficiency. In this case DEA does not differentiate inefficiency from other factors, so inefficiency is often overestimated. On the other hand, in the SFA method this deficiency can be avoided, because SFA can distinguish bias as inefficiency and statistical noise. Furthermore, with a parametric approach the author can observe the influence of input on output. (Hjalmarsson et al., 1996). SFA's ability to analyze panel data adds to the list of advantages of using SFA over DEA. In this research, the author chooses SFA in measuring firm efficiency following Nguyen and Swanson (2009), Nguyen et al. (2019), Pham (2018), Ang et al. (2020) and Ang et al. (2021), Gaganis et al. (2013) and Neukirchen et al., (2022) with the following SFA model:

$$V_< = f\ (X_<;\ \beta)\ exp(e_<)$$

In this case:

| | |
|---|---|
| $V_i$ | Firm value i |
| $f\ (X_<;\ \beta)$ | Input vector X and parameter estimation vector $\beta$ |
| $e_<$ | Error calculated with vi – ui. vi is the standard two-sided white noise error. ui is standard one-sided error. |

Based on Nguyen and Swanson (2009), Nguyen et al. (2019) and Neukirchen et al., (2022), in estimating efficiency, the output used is Tobin's Q. Using the log transformation of the equation above and Total Assets, Long term debt/Asset, Capex/Sales, EBITDA/Sales, Net Property/Sales is proxied as a company characteristic. The following are the equations for determining firm efficiency parameters:

$$ln(Market\ Equity) = \beta_P + \beta_R\ ln(Total\ Asset\ ) + \beta_U\ (LEV) + \beta_W X \frac{CAPEX}{Sales}[ + \beta_\backslash ]\frac{EBITDA}{Sales}c + \beta_d ]\frac{Net\ Property}{Sales}c + vi - u$$

In this case:

| | |
|---|---|
| $\ln(Market\ Equity)$ | Natural Logarithm of Tobin's Q<br>Tobins'Q = (*Market Value of Equity* +Total Liability)/Total Asset |
| $ln(Total\ Asset\ )$ | Natural Logarithm of Total aset |
| $LEV$ | Long term debt / Total Aset |
| $X\frac{CAPEX}{Sales}[$ | *Capital Expenditure* divided by Total Sales |
| $X\frac{EBITDA}{Sales}[$ | EBITDA divided by Total Sales |
| $\frac{Net\ Property}{Sales}$ | *Net Property* divided by Total Sales |
| $v_i - u_i$ | If ui > 0, there is a difference between efficient and inefficient companies. |

After the efficiency parameters are calculated, the next step is to determine the company's efficiency score (EFFi) with the following equation:

$$EFF_{<} = \frac{E\ (V_{i,qi},r_i)}{E\ (V*_{i,qi},r_i)}$$

In this case:

| | |
|---|---|
| $E$ | Expected value |
| $V*_{<}$ | V* is the estimated value of the frontier company or minimum inefficiency |

In the research model, firm efficiency is proxied by the EFF variable which is the firm efficiency score obtained from Stochastic Frontier Analysis (SFA). The value of the EFF variable is between 0 and 1. Companies that are more efficient will have a higher efficiency score, EFFit. For example, a company with an efficiency score of 0.75 means the company has achieved 75% performance compared to its optimal value. A company is categorized as more efficient if the score of the EFF variable is close to 1, and a company is categorized as inefficient if the score of the EFF variable is close to 0.

**Firm Value Measurement**

The dependent variable in this research is firm value. Firm value is proxied by TobinsQ and Price Book Value (PBV). In this research, it is assumed that financial reports can be accessed in real-time with XBRL technology, so that firm value calculations do not use gap years.

i. Tobin's Q

One of the ratios used to measure firm value is Tobin's Q. By calculating the closing price of shares at the end of the year multiplied by the number of shares outstanding, added to the total of all company debt, then the results are compared with the company's total assets. Here's the equation:

$$Tobin\ s\ Q = \frac{(wlosing\ p{\sim}ice\ x\ \zeta qtstanding\ s\ddot{U}a{\sim}e)\acute{a}Total\ Liabilities}{Total\ \tilde{a}sset}$$

ii. PBV

PBV is used in this research as another proxy for firm value. PBV is a ratio that shows whether the traded share price is overvalued or undervalued relative to the book value of the share. Here's the equation:

$$PBV = \frac{Ha{\sim}ga\ sa\ddot{U}am\ pe{\sim}\ lemba{\sim}}{Nilai\ Bqkq\ sa\ddot{U}am\ pe{\sim}\ lemba{\sim}}$$

**Data Method Analysis**

Linear regression analysis in this study is divided into two parts, namely linear regression analysis of hypotheses 1 and 2; and linear regression analysis of hypotheses 3, 4 and 5. This separation was carried out to facilitate analysis where hypotheses 1 and 2 are linear regression analysis which aim to see the influence of IT investment and the Covid-19 pandemic on firm efficiency, while hypotheses 3, 4 and 5 are linear regression analysis which aim to see the influence of firm efficiency and its interaction with firm value.

**Hypothesis 1 and 2 test:**

$$\underset{i,t}{EFF} = Q_0 + Q_1 IT\_INVEST + Q_2 COVID + Q_3 SIZE + Q_4 LEV + Q_5 CASH\_HOLDING + e_{it}$$

**Table 1. In this case:**

| | |
|---|---|
| $EFF$ | Firm Efficiency as measured by income-to-cost ratio (ICR) and Stochastic Frontier Analysis (SFA) |
| $IT\_INVEST$ | IT Investments as measured by the Natural Logarithm of IT Investments |
| $COVID$ | COVID-19 pandemic and non-Covid Pandemic periods as measured by dummy variables. 1 for the Covid pandemic period and 0 for the non-Covid pandemic period. |
| $SIZE$ | Company size as measured by Ln (Total Assets) |
| $LEV$ | Financial Leverage as measured by dividing long-term debt by total assets |
| $CASH\_HOLDING$ | Cash Holding is measured by dividing cash and marketable securities by total assets |

**Hypotheses 3, 4, and 5 Test:**

The regression model used in this research is a modified regression model from research by Nguyen and Swanson (2009), Nguyen et al. (2019) and Neukirchen et al.,

(2022) and added the moderating variable IT Investment and the Covid-19 Pandemic. With the following equation:

$$\text{VALUE}_{¥,\mu} = \beta_P + \beta_R\text{EFF} + \beta_U\text{IT}_{\text{IN}ºÉSø} + \beta_W\text{COVID} + \beta_R\text{EFF} * \text{IT\_INVEST} + \beta_U\text{EFF} * \text{COVID} + \beta_\backslash\text{SIZE} + \beta_d\text{LEV} + \beta_Ç\text{CASH\_HOLDING} + +e_{¥\mu}$$

**Table 2**. In this case

| | |
|---|---|
| $VALUE_{<,t}$ | Firm value proxied with 2 proxies namely TobinsQ, and PBV |
| $EFF$ | Firm Efficiency as measured by Income to Cost Ratio (ICR) and Stochastic Frontier Analysis (SFA) |
| $IT\_INVEST$ IT | Investments as measured by theNatural Logarithm of IT Investments |
| $COVID$ | Covid Pandemic and non-Covid Pandemic periods as measured by dummy variables. 1 for the Covid pandemic period and 0 for the non-Covid pandemic period. |
| $SIZE$ | Company size as measured by Ln (Total Assets) |
| $LEV$ | Financial Leverage as measured by dividing long-term debt by total assets |
| $CASH\_HOLDING$ | Cash Holding as measured by dividing cash and marketable securities by total assets |

## 4. Empirical Findings/Result

This study examines the effect of firm efficiency on firm value. A total of 679 companies listed on the IDX were included in this study population and used purposive sampling methods to obtain research samples. The criteria for the research sample are active stocks listed on the Indonesia Stock Exchange (IDX) during the period 2018 - 2021, and provide complete data needed in the research (Table 3).

The descriptive statistics presented in Table 4, consist of the smallest value (Min), the largest value (Max), the average value of the data (mean), the middle value (median), and the standard deviation of the dependent variable (Firm value proxied by TOBINSQ variables, and PBV), independent variables (Firm efficiency proxied by ICR and SFA; and Covid-19 Pandemic), as well as control variables (SIZE, LEV and CASH_HOLDING).

Testing hypothesis 1 and hypothesis 2, namely the effect of IT investment and the Covid-19 Pandemic on firm efficiency, can be seen in Table 5. Hypothesis testing 3,

4 and 5 is a test of the effect of firm efficiency proxied with firm efficiency scores from SFA (SFA) and Income to Cost Ratio (ICR) on firm value proxied with Tobin's Q (Table 6) and PBV (Table 7).

**Table 4**. Descriptive Statistics

| **Variabel Non Dummy** | **Min** | **Maks** | **Mean** | **Median** | **Standar Deviasi** | **No Obs** |
|---|---|---|---|---|---|---|
| TOBINSQ | 0,3799 | 6,7334 | 1,4729 | 1,0584 | 1,1575 | 612 |
| PBV | 0,2012 | 16,2087 | 2,1417 | 1,2449 | 2,7148 | 612 |
| SFA | 0,1396 | 1,0000 | 0,5636 | 0,5364 | 0,2041 | 612 |
| ICR | 0,6484 | 1,8628 | 1,1246 | 1,0866 | 0,2041 | 612 |
| IT_INVEST | - | 17,9629 | 9,5465 | 11,3408 | 5,4065 | 612 |
| SIZE | 15,0464 | 22,8812 | 19,4861 | 19,4696 | 1,6142 | 612 |
| LEV | 0,0393 | 0,8866 | 0,4550 | 0,4527 | 0,2098 | 612 |
| CASH_HOLDING | 0,0046 | 0,4924 | 0,1300 | 0,0957 | 0,1149 | 612 |
| SFA*IT_INVEST | 0 | 16,2726 | 5,4019 | 5,4192 | 3,7907 | 612 |
| ICR*IT_INVEST | 0 | 28,2335 | 10,8177 | 12,0883 | 6,6786 | 612 |
| SFA*COVID | 0 | 1 | 0,2686 | 0,6981 | 0,3059 | 612 |
| ICR*COVID | 0 | 1,8628 | 0,5550 | 0,3241 | 0,5772 | 612 |
| **Variabel Dummy** | **Jumlah Nilai 0** | **% Nilai 0** | **Jumlah Nilai 1** | **% Nilai 1** | | **No Obs** |
| COVID | 306 | 50,00% | 306 | 50,00% | | 612 |

Hypothesis 1 in this research is that IT investment has a positive effect on firm efficiency. Hypothesis 2 in this research is that the Covid-19 pandemic has a negative effect on firm efficiency. The dependent variable in hypotheses 1 and 2 is firm efficiency (EFF) which is proxied by two variables, namely the firm efficiency score from SFA (SFA) and Income to Cost Ratio (ICR). The independent variables in this research are the natural logarithm of IT investment (IT_INVEST) and the Covid-19 pandemic (COVID). Testing hypotheses 1 and 2 is a test of the influence of IT investment and the Covid-19 pandemic on firm efficiency.

Hypothesis 1 in this research states that IT investment has a positive influence on firm efficiency. Based on table 5, the IT_INVEST variable has a negative coefficient value of 0.00346 on the ICR value, which means that the higher IT investment will reduce the company's efficiency value with a significance level at the 5% level. Where the greater the IT investment a company makes, the lower the company's efficiency level. In contrast to the IT_INVEST variable which has a positive coefficient value of 0.000864 on the SFA value, which means that the higher IT investment will increase the company's efficiency value but with a significance level at a level above 10%.

Hypothesis 2 in this research states that the Covid-19 pandemic has a negative influence on firm efficiency. Based on table 5, the COVID variable has a coefficient of 0.0384 on the ICR value in a negative direction, which means that the Covid-19

pandemic has a negative influence on firm efficiency at a significance level of 1%. In line with the COVID variable, it has a coefficient of 0.0611 on the SFA value in a negative direction, which means that the Covid-19 pandemic has a negative influence on firm efficiency at a significance level of 1%.

**Table 5**. Hypothesis Test Results 1 & 2

| **Variable** | **Predictive Direction** | **Firm Efficiency (EFF)** | |
|---|---|---|---|
| | | **ICR** | **SFA** |
| IT_INVEST | (+) | -0.00346** | 0,000864 |
| | | (0.00167) | (0,00157) |
| COVID | (-) | -0.0384*** | -0,0611*** |
| | | (0.0123) | (0,0161) |
| SIZE | (-) | 0.221*** | -0,0117** |
| | | (0.0403) | (0,00564) |
| LEV | (+) | -0.463*** | 0,154*** |
| | | (0.0982) | (0,0443) |
| CASH_HOLDING | (-) | 0.0988 | 0,340*** |
| | | (0.120) | (0,0756) |
| Constant | | -2.938*** | 0,700*** |
| | | (0.765) | (0,101) |
| No of Obs | | 612 | 612 |
| F-Test | | 10.24*** | 7.26*** |

The results of processing the author's data (data processed). The ***,** and * signs indicate significance at levels of 1%, 5% and 10%, respectively. **SFA** = Firm efficiency Score obtained from Stochastik Frontier Analysis; **ICR** = Income to Cost Ratio which is calculated by dividing Income by Operating Expenses at the end of the financial year; **IT_INVEST** = IT investments obtained from the Natural Logarithm of IT Investments; **COVID** = Covid Pandemic and non-Covid Pandemic period as measured by dummy variables. 1 for the Covid pandemic period and 0 for the non-Covid pandemic period; **SIZE** = Company Size obtained from the Natural Logarithm of Total Assets; **LEV** = Financial Leverage obtained from dividing long-term debt by total assets; **CASH_HOLDING** = Cash Holding as measured by dividing cash and marketable securities by total assets.

The regression test on Hypotheses 3, 4 and 5 was carried out by looking at the effect of firm efficiency which was proxied by the firm efficiency score from SFA (SFA) and Income to Cost Ratio (ICR) on firm value which was proxied by Tobin's Q. The regression test was carried out with two models, namely models without a moderating variable (Model 1a and Model 2a) and models with a moderating variable (Model 1b and Model 2b). Based on Model 1a in table 6, the SFA coefficient value for Tobin's Q is 2.370 with a significance level of 1%. In line with Model 2a which shows that the

ICR coefficient value for Tobin's Q is 0.955 with a significance level of 1%. This shows that the more efficient the company will increase the value of the company.

Based on Model 1b in table 6, the change in the SFA coefficient value of Tobin's Q is 1.912 with a significance level of 1%. It can be interpreted that by using the moderating variables SFA*IT_INVEST and SFA*COVID, the SFA coefficient becomes 1.912. The SFA coefficient value is lower than before the moderating variable existed. The results of this regression show that the moderating variable in the form of the SFA*COVID interaction has a positive coefficient value of 0.542 with a significance level of 1%. This shows that the influence of firm efficiency on firm value will strengthen with the Covid-19 pandemic. In other words, the Covid-19 pandemic strengthens the relationship between firm efficiency and firm value. The results of this regression also show that the moderating variable in the form of the SFA*IT_INVEST interaction has a positive coefficient of 0.0210 with a significance level above 10%. Based on the regression results of Model 2b in table 6, the change in the ICR coefficient value of Tobin's Q was found to be 1.066 with a significance level of 1%. It can be interpreted that by using the moderating variables ICR*IT_INVEST and ICR*COVID, the ICR coefficient will be 1.066. The ICR coefficient value is lower than before the moderating variable was introduced. The regression results of Model 2b also show that the moderating variable in the form of the ICR*COVID interaction has a positive coefficient value of 0.461 with a significance level above 10%. The results of this regression also show that the moderating variable in the form of the ICR*IT_INVEST interaction has a negative coefficient of 0.0706 with a significance level of 5%. This shows that the influence of firm efficiency on firm value will weaken with IT investment.

Based on table 6 in model 1b, it can be seen that SFA+SFA*IT_INVEST has a positive coefficient of 1.933 with a significance level of 1%. This shows that jointly/simultaneously the SFA and SFA*IT_INVEST variables have a significant positive influence on firm value with the Tobin's Q proxy. Apart from that, in this model it can also be seen that SFA+SFA*COVID has a positive coefficient of 2.454 with a significance level 1%. This shows that jointly/simultaneously the SFA and SFA*COVID variables have a significant positive influence on firm value with the Tobin's Q proxy.

Based on table 6 in model 2b, it can be seen that ICR+ICR*IT_INVEST has a positive coefficient of 0.9954 with a significance level of 5%. This shows that jointly/simultaneously the ICR and ICR*IT_INVEST variables have a significant positive influence on firm value with the Tobin's Q proxy. Apart from that, in this model it can also be seen that ICR+ICT*COVID has a positive coefficient of 1.527 with a significance level 1%. This shows that jointly/simultaneously the ICR and ICR*COVID variables have a significant positive influence on firm value with the Tobin's Q proxy.

Based on table 6, the F-Test results for all models are <0.05, meaning that firm efficiency is proxied by SFA and ICR, the moderating variables SFA*IT_INVEST and SFA*COVID, and the control variables in the form of SIZE, LEV, and CASH_HOLDING together/simultaneously significant effect on firm value (Tobin's Q).

**Table 6**. Hypothesis Test Results 3, 4 and 5 (Tobin's Q Proxy)

Model 1a & 2a : $VALUE_{i,t} = \beta_0 + \beta_1 EFF + \beta_2 IT\_INVEST + \beta_3 COVID + \beta_4 EFF * IT\_INVEST + \beta_5 EFF * COVID + \beta_6 SIZE + \beta_5 LEV + \beta_6 CASH\_HOLDING + e_{it}$

Model 1b & 2b : $VALUE_{i,t} = \beta_0 + \beta_1 EFF + \beta_2 IT\_INVEST + \beta_3 COVID + \beta_4 SIZE + \beta_5 LEV + \beta_6 CASH\_HOLDING + e_{it}$

| Variable | Predictive Direction | Tobin's Q | | | |
|---|---|---|---|---|---|
| | | Model 1a | Model 1b | Model 2a | Model 2b |
| SFA | (+) | 2.370*** | 1.912*** | | |
| | | (0.250) | (0.413) | | |
| ICR | (+) | | | 0.955*** | 1.066** |
| | | | | (0.205) | (0.415) |
| IT_INVEST | (+) | -0.000223 | -0.0118 | 0.00826 | 0.0867** |
| | | (0.00741) | (0.0191) | (0.00752) | (0.0402) |
| COVID | (-) | 0.201*** | -0.101 | 0.114** | -0.426 |
| | | (0.0564) | (0.160) | (0.0578) | (0.378) |
| SFA*IT_INVEST | (+) | | 0.0210 | | |
| | | | (0.0315) | | |
| ICR*IT_INVEST | (+) | | | | -0.0706** |
| | | | | | (0.0345) |
| SFA*COVID | (-) | | 0.542** | | |
| | | | (0.270) | | |
| ICR*COVID | (-) | | | | 0.461 |
| | | | | | (0.334) |
| SIZE | (+) | 0.467*** | 0.458** | -0.0998* | 0.314 |
| | | (0.178) | (0.178) | (0.0512) | (0.206) |
| LEV | (-) | -1.065** | -1.169*** | 0.0615 | -0.489 |
| | | (0.435) | (0.436) | (0.320) | (0.494) |
| CASH_HOLDING | (-) | 0.446 | 0.400 | 1.076** | 0.894 |
| | | (0.533) | (0.532) | (0.467) | (0.576) |
| Constant | | -8.628** | -8.148** | 2.040** | -5.852 |
| | | (3.385) | (3.383) | (0.919) | (3.938) |
| No of Obs | | 612 | 612 | 612 | 612 |
| SFA + SFA*IT_INVEST | | | 1.933*** | | |
| | | | (24,54) | | |
| SFA + SFA*COVID | | | 2.454*** | | |
| | | | (30.24) | | |
| ICR + ICR*IT_INVEST | | | | | 0.9954** |
| | | | | | (6.43) |
| ICR + ICR*COVID | | | | | 1.527*** |

| | | | | |
|---|---|---|---|---|
| | | | | (11.92) |
| F-Test | 18.11*** | 14.28*** | 365*** | 3.74*** |

The results of processing author data (data processed). The ***,** and * signs indicate significance at levels of 1%, 5% and 10%, respectively. Model 1a and Model 2a are models prior to interaction; Model 1b and Model 2b are models after interaction. SFA = Firm efficiency Score obtained from Stochastik Frontier Analysis; ICR = Income to Cost Ratio which is calculated by dividing Income by Operating Expenses at the end of the financial year; IT_INVEST = IT Investment obtained from the Natural Logarithm of IT Investment; COVID = Covid Pandemic and non-Covid Pandemic period as measured by dummy variables. 1 for the Covid pandemic period and 0 for the non-Covid pandemic period; SFA*IT_INVEST = SFA interaction with IT_INVEST; SFA*COV ID = Interaction between SFA and COVID; ICR*IT_INVEST = ICR interaction with IT_INVEST; ICR*COV ID = Interaction between ICR and COVID; SIZE = Company Size obtained from the Natural Logarithm of Total Assets; LEV = Financial Leverage obtained from dividing long- term debt by total assets; CASH_HOLDING = Cash Holding as measured by dividing cash and marketable securities by total assets.

Another measurement used in firm value is PBV. The regression test on Hypotheses 3, 4 and 5 was carried out by looking at the effect of firm efficiency as proxied by the firm efficiency score from SFA (SFA) and Income to Cost Ratio (ICR) on firm value as proxied by PBV. The regression test was carried out with two models, namely a model without a moderating variable (Model 1a and Model 2a) and a model with a moderating variable (Model 1b and Model 2b).

Based on Model 1a in table 7, the SFA coefficient value on PBV is 4.841 with a significance level of 1%. This shows that the more efficient the company will increase the value of the company. In line with Model 2a which shows that the ICR coefficient value for PBV is 0.604. This shows that firm efficiency has a positive effect on firm value.

Based on Model 2a in table 7, the change in the SFA coefficient value on PBV is 3.967 with a significance level of 1%. It can be interpreted that by using the moderating variables SFA*IT_INVEST and SFA*COVID, the SFA coefficient becomes 3.967. The SFA coefficient value is lower than before the moderating variable existed. The results of this regression show that the moderating variable in the form of the SFA*COV interaction has a positive coefficient value of 1.752 with a significance level of 1%. This shows that the influence of firm efficiency on firm value will strengthen with the Covid-19 pandemic. In other words, the Covid-19 pandemic strengthens the relationship between firm efficiency and firm value. The results of this regression also show that the moderating variable in the form of the SFA*IT_INVEST interaction has a positive coefficient of 0.00838 with a significance level above 10%.

Based on the regression results of Model 2 in table 7, a change in the ICR coefficient value on PBV was found to be 1.394 with a significance level above 10%. It can be interpreted that by using the moderating variables ICR_IT_INVEST and ICR_COV, the ICR coefficient becomes 1.394. The ICR coefficient value is higher than before the moderating variable existed. The regression results of Model 2 also show that the

moderating variable in the form of the ICR_COV interaction has a positive coefficient value of 0.475 with a significance level above 10%. The results of this regression also show that the moderating variable in the form of the ICR_IT_INVEST interaction has a negative coefficient of -0.112 with a significance level above 10%.

Based on table 7 in model 1b, it can be seen that SFA+SFA*IT_INVEST has a positive coefficient of 3.9754 with a significance level of 1%. This shows that jointly/simultaneously the SFA and SFA*IT_INVEST variables have a significant positive influence on firm value with the PBV proxy. Apart from that, in this model it can also be seen that SFA+SFA*COVID has a positive coefficient of 5.719 with a significance level of 1%. This shows that jointly/simultaneously the SFA and SFA*COVID variables have a significant positive influence on firm value with the PBV proxy.

Based on table 7 in model 2b, it can be seen that ICR+ICR*IT_INVEST has a positive coefficient of 1.282 with a significance level above 10%. In this model it can also be seen that ICR+ICT*COVID has a positive coefficient of 1.869 with a significance level of 10%. This shows that jointly/simultaneously the ICR and ICR*COVID variables have a significant positive influence on firm value with the PBV proxy.

Based on table 7, the F-Test results for all models are <0.05, meaning that firm efficiency is proxied by SFA and ICR, the moderating variables SFA*IT_INVEST and SFA*COVID, and the control variables in the form of SIZE, LEV, and CASH_HOLDING together/simultaneously has a significant effect on firm value (PBV).

**Table 7.** Hypothesis Test Results 3, 4 and 5 (PBV Proxy)

Model 1a & 2a $\text{VALUE}_{i,t} = \beta_0 + \beta_1 \text{EFF} + \beta_2 \text{IT\_INVEST} + \beta_3 \text{COVID} + \beta_4 \text{SIZE} + \beta_5 \text{LEV} + \beta_6 \text{CASH\_HOLDING} + e_{it}$

Model 1b & 2b $\text{VALUE}_{i,t} = \beta_0 + \beta_1 \text{EFF} + \beta_2 \text{IT\_INVEST} + \beta_3 \text{COVID} + \beta_1 \text{EFF} * \text{IT\_INVEST} + \beta_2 \text{EFF} * \text{COVID} + \beta_4 \text{SIZE} + \beta_5 \text{LEV} + \beta_6 \text{CASH\_HOLDING} + e_{it}$

| Varible | Predictive Direction | PBV | | | |
|---|---|---|---|---|---|
| | | Model 1a | Model 1b | Model 2a | Model 2b |
| SFA | (+) | 4.841*** | 3.967*** | | |
| | | (0.619) | (1.022) | | |
| ICR | (+) | | | 0.604 | 1.394 |
| | | | | (0.547) | (1.014) |
| IT_INVEST | (+) | 0.00832 | 0.00401 | 0.0188 | 0.147 |
| | | (0.0184) | (0.0473) | (0.0196) | (0.0981) |
| COVID | (-) | 0.521*** | -0.451 | 0.247* | -0.270 |
| | | (0.140) | (0.395) | (0.145) | (0.924) |
| SIZE | (+) | 1.331*** | 1.284*** | 1.225** | 1.237** |
| | | (0.442) | (0.441) | (0.485) | (0.502) |
| LEV | (-) | 1.221 | 0.933 | 2.145* | 1.993* |
| | | (1.079) | (1.080) | (1.172) | (1.206) |
| CASH_HOLDING | (-) | 1.215 | 1.092 | 2.504* | 2.280 |
| | | (1.322) | (1.316) | (1.396) | (1.406) |
| SFA*IT_INVEST | (+) | | 0.00838 | | |
| | | | (0.0780) | | |
| ICR*IT_INVEST | (+) | | | | -0.112 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | (0.0843) |
| SFA*COVID | (-) | | 1.752*** | | |
| | | | (0.668) | | |
| ICR*COVID | (-) | | | | 0.475 |
| | | | | | (0.817) |
| Constant | | -27.57*** | -26.00*** | -24.02*** | -25.04*** |
| | | (8.394) | (8.370) | (9.071) | (9.615) |
| No of Obs | | 612 | 612 | 612 | 612 |
| SFA + SFA*IT_INVEST | | | 3.9754*** | | |
| | | | (16.96) | | |
| SFA + SFA*COVID | | | 5.719*** | | |
| | | | (26.83) | | |
| ICR + ICR*IT_INVEST | | | | | 1.282 |
| | | | | | (1.79) |
| ICR + ICR*COVID | | | | | 1.869* |
| | | | | | (2.99) |
| F-Test | | 16.02*** | 13.03*** | 5.36*** | 4.25*** |

The results of processing author data (data processed). The ***,** and * signs indicate significance at levels of 1%, 5% and 10%, respectively. Model 1a and Model 2a are models prior to interaction; Model 1b and Model 2b are models after interaction. SFA = Firm efficiency Score obtained from Stochastik Frontier Analysis; ICR = Income to Cost Ratio which is calculated by dividing Income by Operating Expenses at the end of the financial year; IT_INVEST = IT Investment obtained from the Natural Logarithm of IT Investment; COVID = Covid Pandemic and non-Covid Pandemic period as measured by dummy variables. 1 for the Covid pandemic period and 0 for the non-Covid pandemic period; SFA*IT_INVEST = SFA interaction with IT_INVEST; SFA*COV ID = Interaction between SFA and COVID; ICR*IT_INVEST = ICR interaction with IT_INVEST; ICR*COV ID = Interaction between ICR and COVID; SIZE = Company Size obtained from the Natural Logarithm of Total Assets; LEV = Financial Leverage obtained from dividing long- term debt by total assets; CASH_HOLDING = Cash Holding as measured by dividing cash and marketable securities by total assets.

## 5. Discussion

Hypothesis 1 is not supported because IT investment negatively affects the firm efficiency. This is because of two things, namely the paradox of IT productivity and the time lag effect. (Brynjolfsson, 1993; Campbell and Cocco, 2015). This paradox of IT productivity is the misalignment between IT investments and improved company performance. According to (Lee *et al.*, 2016) IT investment is a large amount of investment issued by the company. To feel the benefits, this IT investment must be supported by qualified human resource capabilities to achieve IT capabilities. Until IT capabilities are ready, IT investments will have no impact on company performance.

In addition, (Brynjolfsson, 1993) found that IT investment has an effect on decreasing productivity because companies rarely restructure and cost-cutting.

In addition to the paradox of IT productivity, time is an important contextual factor in IT investments. It takes time for companies to feel the business benefits of IT investment because it takes quite a lot of time for companies to develop their ability to implement IT, so that then feel the benefits of IT investment (Campbell and Cocco, 2015). (Ji, Yan and Shi, 2022) stated that there is a "time lag effect" of IT investment on company performance and his research found that it takes an average of about 3 (three) to 4 (four) years after the investment year for companies to feel the benefits of IT investment

Hypothesis 2 was accepted because the Covid-19 pandemic negatively affected the firm efficiency. This is because the crisis caused by the Covid-19 pandemic has caused idle capacity, which encourages low production efficiency and a decrease in the ability to convert production into sales (Kirkulak and Erdem, 2014; Gulati and Kumar, 2016; Martínez-Campillo and Fernández-Santos, 2020; Fernandes, de Araujo and Tabak, 2021; Zheng and Zhang, 2021).

Hypothesis 3 is accepted because the firm efficiency positively affects the value of the company. This is because a more efficient company will respond positively by investors than an inefficient company, so investors will give high firm value. This is because companies that are more efficient at using funds are better off, and have a lower risk of default. In addition, corporate inefficiency is one of the risks that cannot be diversified so it is unlikely that this risk can be fully captured by the market (Frijns, Margaritis and Psillaki, 2012).

Hypothesis 4 is not supported because IT investment weakens the relationship between firm efficiency on firm value. The test results in this study are supported by previous researchers who show a negative influence of IT investment on company performance and ultimately have an impact on the decline in firm value (Stores *et al.*, 2018; Thakurta and Guha Deb, 2018). This negative influence is due to insufficient resources, the additional costs associated with IT investment are not proportional to the increase in performance, the paradox of IT productivity, and the time lag effect. The lower the company's performance, the lower firm value (Bukit *et al.*, 2018).

Hypothesis 5 is not supported because the Covid-19 pandemic strengthens the relationship between firm efficiency and firm value. The Covid-19 pandemic has encouraged companies to make various adjustments to survive. One of the adjustments made is to apply a Flexible Working Arrangement (FWA). (Emyana andBadar, 2022) revealed that FWA has a positive influence on employee performance and company performance. In line with the research of (Gashi, Kutllovci and Zhushi,2022) that the Covid-19 pandemic has given birth to job flexibility that increases work-life-balance and effectiveness at work so as to increase employee satisfaction. The higher the employee satisfaction, the more it will increase the productivity and efficiency of the company as a whole, so that the company will be given higher valuefrom investor (Best, 2008; Edmans, 2012).

## 6. Conclusions

From the results of the analysis and discussion after statistical testing, the following conclusions were drawn, first, there is a significant negative influence of IT investment on firm efficiency in companies listed on the IDX with the period 2018-2021. Companies with high IT investment can lower firm efficiency by using ICR proxies. In other words, IT investments increase the inefficiencies of the company. Second, there is a significant negative influence of the Covid-19 pandemic on firm efficiency in companies listed on the IDX for the 2018-2021 period. During the Covid-19 pandemic, it was able to reduce firm efficiency by using ICR and SFA proxies. In other words, the Covid-19 pandemic has increased company inefficiencies. Third, there is a significant positive influence of firm efficiency on firm value in companies listed on the IDX for the period 2018-2021. Companies with high efficiency can increase the value of the company. In other words, the higher the efficiency of the company, the higher the value of the company which is reflected in the value of Tobin's Q and PBV. An efficient company has added value that can affect investor interest in deciding on its investment. Four, there is a significant negative moderation relationship between IT investment and firm value in companies listed on the IDX for the period 2018-2021. Where IT investment is able to weaken the relationship of firm efficiency to firm value. In other words, the higher the IT investment made by the company, it will reduce the positive relationship between firm efficiency and firm value. Five, the positive moderation relationship of the Covid-19 pandemic on the value of companies listed on the IDX for the 2018-2021 period. Where the Covid-19 pandemic is able to strengthen the relationship between firm efficiency and firm value. In other words, during the Covid-19 pandemic, the company was able to increase firm value.

The limitation of this study that is expected to be corrected by future studies is that this research does not pay attention to industry groups. So, in the next study it is advisable to pay attention to industry groups to compare the efficiency of companies in different industry groups in influencing firm value. This study did not pay attention to the time lag effect of IT investment. So, in the next study, it is recommended to multiply the years studied in order to compare the relationship of IT investment to firm efficiency. This study used a research framework that was tested separately with a non-integrated model. So, in the next study it is recommended that you can test with an integrated model.

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