Macrothink Institute™

Business and Economic Research
ISSN 2162-4860
2024, Vol. 14, No. 1

Can Technological Advancements be Effective for the Economic Value of the Companies? Insights from the DSE Listed Food and Allied Companies

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Received: January 17, 2024 Accepted: March 5, 2024 Published: March 23, 2024

doi:10.5296/ber.v14i1.21624 URL: https://doi.org/10.5296/ber.v14i1.21624

Abstract

Purposes: Adopting technology in the production process increases the overall efficiency of inputs used in the production, and enhances a firm's economic value. **Methodology:** This study tries to explore the impact of technology on firm performance from 8 listed Food and Allied companies spanning 2015-2021 listed on DSE. Total factor productivity (TFP) is an inclusive measure that apprehends the contribution of all aspects that improve the efficiency of production including technology. Therefore, the contribution of technical advancement to the firm is captured by TFP, applying the Solow residual method. TFP is the main study

variable and some other control variables, such as tangibility, liquidity, firm size, and growth; long-term leverage ratio and net debt tax shield are used as exogenous variables to increase the robustness of the model and improve the value of both the firm performance ROA and ROE. **Results:** Finally, this study concluded that investment in technology in the food and allied sectors has a notable impact on a firm's performance. Therefore, the study indicates that economists, policymakers, and business management can use TFP growth as an indicator for making their long-term decision policy and increase the overall sustainable economic productivity, growth and efficiency of the firm and can contribute to accelerating the economic growth of the country.

Keywords: Total production factor (TFP), Technological efficiency, Firm performance (Return on Assets (ROA), Return on Equity (ROE))

1. Introduction

Technology acts as a key indicator in increasing production efficiency and the contribution of technology is captured in the theory of Total factor productivity. Technological advancement can bring substantial change in the outcome of production using the same or lesser amount of production. Digitalization of production enhances the quantity, quality and precision in all spheres of production segments, such as raw material, resource allocation, supply chain management, innovation of new production, better communication and marketing etc. Therefore, technology plays an essential role in improving the production level in an industry and also the growth of TFP as well by fostering a climate of continuous innovation. In essence, technology acts as a catalyst for improved productivity, shaping the TFP landscape and driving economic growth by unlocking new potentials in the production process. Thus, the TFP captures the value of the technological landscape within a specific industry and also reflects its overall growth, effectiveness, and the overall performance of the firm.

Econometric models and statistical methods are used mainly to calculate the value of TFP, which is actually a residual value; this residual value is estimated from a production function. This value represents that portion of output enlargement that occurs apart from the accumulating contribution of inputs, providing a nuanced understanding of a nation's economic productivity and growth dynamics. Usually, a firm's growth becomes prompt due to the efficient decisions of management, employees' skills, technological advancement, quality raw materials and so on. This research uses the Solow residual method to calculate the TFP value which only assesses the growth due to technological advancement and will find out whether TFP is a factor in changing the economic value of the firm's economic performance.

Technology has had a profound impact on the food industry, transforming various aspects of production, distribution, and consumption. Adopting advanced technology continues to shape and improve efficiency, sustainability, and consumer experiences in the food industry. Production is one of the fundamental factors in sustainability, and using sustainable practices is crucial for a well-built and long-lasting global economy. TFP represents the enduring efficiency and effectiveness of the production process. As a measure of how efficiently an economy utilizes its inputs to generate output, TFP captures the essence of long-term

economic health, therefore TFP is important for long-term economic health, showing how consistently an economy can improve productivity. It considers technological advancements, innovations, and overall production efficiency, driving ongoing economic growth. Policymakers and analysts watch TFP trends closely to understand the economy's strength and potential for long-term success. Essentially, TFP helps build a solid foundation for a resilient and lasting economic growth path.

There exists a long-run relationship between TFP and economic growth as well and in the short-run, this relationship also exists (Siddique, 2020). TFP has significant contributions to economic growth and production levels in Southeast Asian countries like Pakistan, (Shahazad & Khan, 2019). TFP grows at different stages of income which contribute in a profound manner in innovative activities and building new capacities which are significant in overcoming all the difficulties when middle-income countries transition to the high-income group (Kim & Park, 2017). On a specific note, the largest contributor amongst the determinants, which are established by different studies, to the variance in TFP growth, is market efficiency. It has been observed to have a positive-significant relationship with the proposed TFP determinant and a negative relationship with the initial TFP (Kim et al., 2019). Education as well as the effects of Technological advancement on Work has positive implications for vocational training (Beer, 2020).

The impact of technology has three major areas- the persistence in technological progress over time accompanied by multiple adoption decisions over a long horizon, and the impact of production-based learning on those decisions. (Chambers, 2004). Technological advancement has a significant relationship with motivations and training employees in which motivation can be argued to have a visible effect on employee performance but on the other hand, employee performance has no significant relationship with training (Imran, 2014).

The food industry is one of the most noteworthy sectors in Bangladesh since it keeps contributing to the country's GDP as well as enhancing the field of employment by using the labor force. According to the GDP, the contribution of the food sector for the last five years in its GDP is 15.47%. With the increase in demand, this concept has been shifted from small business to food industry and this dramatic change has been possible via technological advancement. A good packing system has been launched to ensure the quality of food since the world people are becoming conscious about their health. This not only increases the demand for food but also makes the food lucrative to its consumers. That is why, packing, advertising as well as marketing has been the focus point of the food industry. When it has been the taking point of the value chain food processing keeps a vital link between agricultural and food consumption. In this era, modern technologies have been addressed which allows not only to produce maximum amount of products but also preserves those for a long time that can avoid any kinds of damage and rejection. Food industries are keeping a vital role by focusing on four objectives- customer satisfaction, safety, providing product information with the maintenance of commercial viability.

In accordance with the food industries allied industries work together by providing different types of raw materials and services. Since the increase in the population has been too much, it

has also been tough to cope with the demand of the population. So, it has always been a concern for the authority to focus on the productivity and improvement of efficiency in the Food and Allied sector in Bangladesh. Efficient productivity is the result of the efficient use of a country's land, labor, materials, capital, latest technology and best use of the IT sector.

Higher productivity means accomplishing more input with the use of the same resources or producing the same output using less output than before. The expected productivity can be touched either by introducing modern technologies or by upgrading the input's efficiency of existing technologies. With the lack of new technologies and scarcity of resources, substantial efforts have been devoted to finding out the advancement of technology which will be in a position to increase the chances of raising productivity without inaugurating new resources or technologies. In this way, technological advancement is the ability of a particular industry to assemble a certain level of output with a minimum quantity of inputs. Efficient productivity is the result of the efficient use of a country's land, labor, materials, capital, latest technology and best use of IT. If the technological advancement of an industry is okay, then it causes higher productivity which means accomplishing more input with the use of the same resources or producing the same output using less input than the previous one.

In Bangladesh, there isn't any significant work on finding out the impact of technological advancement on firm performance in the Food and allied Industry in Bangladesh. In 2021, VC Junior (Brazil) published a paper where the outcome indicates that there lies a significant positive relationship between technology and production. In accordance with clarifying the TA, the paper will also bring a clear picture of economic return to scales in food and allied sectors in DSE. Besides, it will also notify the degree of relationship and impact between the input as well as output.

2. Literature Review

Akter et al. (2020) conducted a study examining the technical efficiency of pineapple production in Madhupur Upazila of Tangail District. The results revealed a significant correlation between pineapple production quantity and input variables such as area, tillage cost, seedling cost, and human labor cost. Additionally, the age of farmers exhibited a positive impact, while years of schooling had a negative influence on farmer efficiency. In a study by Dharmasiri & Datye (2011), the application of the Cobb-Douglas production function in analyzing agricultural production processes demonstrated a positive statistical relationship between the market price of crop production and its yield. However, no significant relationship was found between the harvested area and yield. Examining the efficiency factors and technological aspects in the Indian food processing industry, Bhandari & Vipin (2016) discovered that units producing dairy products and sugar exhibited lower technological efficiency compared to those involved in producing vegetable oil and related products within the same industry. Yuan (2011) explored the relationship between agricultural output and input factors (fertilizer, manpower, irrigation area, and machine power). The findings indicated that machine power was more effective in increasing productivity than manpower. In a study on sustainable revenue and net profit in the food and allied industry in Bangladesh, Shahria & Jahan (2019) found that promotional costs had a greater impact on

revenue and net profit compared to overall selling and distribution costs and non-promotional expenses. Naglova & Pechrova (2021) investigated the technical efficiency of the food and drink industry and its determining factors. The findings indicated that the size of a company has an impact on its technical efficiency, with variations observed across different branches. The bakery and milk industry exhibited the highest efficiency, while the fruit and vegetable processing industry showed the lowest efficiency. Yacob (2008) focused on the technical efficiency of the food industry in Malaysia, utilizing a Stochastic Frontier Model. The study concluded that the sampled food industry demonstrated high technical inefficiency, with an average efficiency ratio of 0.668. Rahman (2022) explored the impact of the Weighted Average Cost of Capital (WACC) on the profitability of firms in the Food and Allied Industry of Bangladesh. The results indicated a negative and significant relationship between WACC and profitability measures. Kim & Loayza (2021) conducted a study on patterns in growth of productivity and determinants worldwide. The primary outcome highlighted that market efficiency is the most significant contributor to the variance in Total Factor Productivity (TFP) growth, exhibiting a positive and significant relationship with the proposed TFP determinant and a negative relationship with the initial TFP. Khan & Mehboob (2020) investigated Total Factor Productivity (TFP) and economic growth in Pakistan through a time series analysis. The findings suggested the existence of a long-run relationship between TFP and economic growth, with this relationship persisting in the short run as well. In their paper, Khan & Khilji 2019) explored innovation, total factor productivity, and economic growth in Pakistan from a policy-driven perspective. The main conclusion emphasized the significant contributions of innovation to economic growth and production levels in Pakistan. Kim & Park (2017) emphasized that factors such as human capital, a smaller population, a weak currency, and growth in research and development (R&D) significantly contribute to Total Factor Productivity (TFP) growth. The study concluded that TFP experiences growth at different income stages, particularly during the strengthening of innovative activities and the development of new capacities. This growth is crucial for middle-income countries transitioning to high-income status. The governments of upper-middle-income countries are advised to prioritize innovation by optimizing R & D systems and redesigning educational systems to foster innovation.

In the context of Bangladesh, there is a notable absence of substantial research on assessing the influence of technological advancements on firm performance (measured by Return on Assets or Return on Equity). Notably, Vc Junior (2021) found a significant positive relationship between technology and production. This paper aims to elucidate the role of technological advancement in the food and allied sectors on the Dhaka Stock Exchange (DSE). Additionally, it intends to provide insights into the economic returns to scale in this sector, shedding light on the degree of the relationship and the impact of technology on firm performance.

3. Research Questions & Hypothesis

3.1 The Dependent Variable

To acquire the value of a firm's financial value this study used return on assets (ROA) as a

substitute variable, which is calculated by dividing net income by total assets. Return on assets indicates how a firm's asset is utilized to generate revenue which means how a company is profitable to its utilized assets. ROA is a better indicator to measure the performance of the firm by Kusuma (2021).

3.2 The Independent Variables

The majority of independent variables utilized in this study, such as firm size, firm age, leverage, tangibility, growth, and non-debt tax shield, have been widely employed in similar prior research. Tangibility, which assesses the presence of tangible assets like machinery, office furniture, and buildings, represents a significant portion of a company's value. These physical assets reduce risk and uncertainty for consumers in evaluating the industry's offerings. Tangibility is measured as the ratio of fixed assets to total assets and has been found to influence firm performance, as indicated in the research by Yuksel Itlas (2010). Liquidity denotes a company's ability to meet its current liabilities using current assets. It reflects the firm's capacity to convert assets into cash or fulfill short-term obligations with liquid assets. The liquidity ratio, calculated as the ratio of current assets to current liabilities, is a key indicator. Empirical reviews suggest that firms with higher liquidity are more adept at repaying short-term liabilities, while those with lower liquidity face challenges in meeting short-term obligations, as noted by Asif & Murad (2019). Firm size, determined by the total assets used, can also be accessed through parameters like sales, employees, assets, or market value of equity. However, research findings, such as those by Meiryani et al. (2020), indicate that firm size does not significantly influence firm performance. Growth is measured by assessing the change in sales from the base year to the previous year, and it has a discernible impact on firm performance, as highlighted by Yolanda & Beatriz (2018). Another variable, risk, is determined by the ratio of long-term debt to total assets in the firm. Financial leverage, associated with firm performance, has been explored in studies such as those conducted by Zahoor & Huma (2015). Tax shield refers to the tax savings achieved through deducting taxes on a company's net borrowings. The net debt tax shield is calculated using the formula (Depreciation/Total Assets). The payment of interest, when expensed, provides a tax advantage based on a given percentage. Debt tax shields and non-debt tax shields have been found to have a negative relationship with firm performance, as indicated by Sritharan (2015).

The key variable of this research is total factor productivity. Notably, this study deviates by using total factor productivity (TFP) as the primary variable, a measure rarely employed to capture the economic value of a firm. TFP growth reflects the expansion of production resulting from improvements in all input factors beyond technical efficiency. Therefore, the primary aim of this research is to investigate the correlation between TFP and firm performance, specifically Return on Assets (ROA), focusing on the efficiency and effectiveness of resource utilization. The objective is to examine how changes in a firm's TFP impact its output generation, determining whether the firm produces more or less output with the same level of input. Such changes can have a positive influence on financial metrics like Return on Assets (ROA) and Return on Equity (ROE). Numerous researchers have underscored that TFP serves as a crucial determinant influencing alterations in firms'

production patterns.

Imrohoroglu & Tüzel (2014) discovered that firms with low Total Factor Productivity (TFP) are more susceptible to increased business production patterns and, consequently, are riskier compared to firms with high TFP. Several studies have established a positive correlation between TFP and firm value. In a logical sense, TFP growth indicates the efficient utilization of a firm's resources, enabling the firm to lower output prices while maintaining or increasing profit margins. Over the long term, TFP growth contributes to the firm's profitability and sustainability, thereby enhancing shareholders' wealth. VC Junior (2021) concluded that there is a positive effect between technology and food industrial production, with new technology being integrated into the sector rather than created. When the total output grows faster than its input, the total productivity of factors of production, also known as TFP, also increases. In 2005, Li & Mérette indicated that total factor productivity depends on three factors: natural resources, technological resources, and human resources. The performance of a firm is significantly reliant on TFP (Dvoulety & Blazkova, 2022). Existing research suggests that TFP acts as an influence on production changes. Therefore, the main hypothesis of this research is to examine the relationship between an increase in a firm's value and technological production improvement achieved by increasing production levels.

H1: There is no significant link between technological advancement and a firm's economic value.

4. Methodology

The study implied panel data to analyze the technological advancements impact on a firm's performance. Panel data is the combination of cross-section and time-series variation and has two dimensions to the model to run panel regression by employing panel econometric analysis. Therefore, the expression of the regression model is the following equation. Here i represent the corresponding companies and t represents the corresponding year:

Model 1:

$$(ROA)it = \beta0 + \beta1(risk)it + \beta2\ (Fage)it + \beta3(Growth)it + \beta4(Tangibility)it + \beta5(FSize)it + B6(liquidity)it + \beta\ 7\ (NDTS)\ it + B8\ (TFP)\ it + €it \quad (1)$$

Model 2:

$$(ROE)it = \beta0 + \beta1(risk)it + \beta2\ (Fage)it + \beta3(Growth)it + \beta4(Tangibility)it + + \beta5(FSize)it + \beta\ 6(liquidity)it + \beta7\ (NDTS)\ it + \beta8(TFP)\ it + €it \quad (2)$$

Table 1. Explanation of the Dependent and Control Variables

Dependent Variables		
Variable	**Substitute Variables & Symbols**	**Empirical Research**
Firm's Profitability	ROA = Net income/total assets	Kusuma, M. 2021
	ROE = Net income/total equity	
Independent Variables		
Total Factor Productivity	TFP= Total production / Total input	Dvoulety, O. & Blazkova, I. 2022
risk	LTD= Long-term debt/ total assets	Zahoor & Huma, 2015
Fage	Fage= Ln(current year- year of incorporation)	Pervan et al. 2017
Firm size	FSize= ln(Total Assets)	Meiryani & Sudrajat, J. 2020
Tangibility	Tang= Net fixed assets/total assets	Itlas, Y., 2010
Liquidity	Liquidity = ln(Current Assets/ Current liability	Asif & Murad, 2019
Non-debt tax shield	NDTS = Depreciation/ Total Assets	Vinasithambysritharan, 2015

4.1 Estimation of Total Factor Productivity

Total Factor Productivity (TFP) serves as a comprehensive measure encompassing various factors that enhance production efficiency. The surge in production can be attributed to multiple factors, with technological progress being a primary driver. This study aims to capture the expansion in production resulting from advancements in technology. Different methods exist for estimating TFP, and one of the simplest is the Solow residual method (Solow, 1957), often estimated through Ordinary Least Squares (OLS). In the Cobb-Douglas production function, TFP is viewed as a geometrically weighted average of the productivity of capital, labor, and raw materials. Originally formulated by John W. Kendrick, this model initially considered labor and capital factors for TFP calculation. However, this paper extends the analysis by incorporating raw materials along with labor and capital to derive the TFP value. The focus of this research is primarily on evaluating the overall operational efficiency performance.

The research will use the Cobb-Douglas production function,

$$Y_{it} = A_{it}\beta^{l}L_{it}\beta^{k}K_{it}\beta^{\mathrm{m}}\,\mathrm{M}_{it}$$

Where, Y_{it} = Physical output of firm i in period t;

L_{it} = The inputs of labor, and

K_{it} = Capital.

M_i = Raw Materials

A_{it} = Hicks neutral efficiency level of firm i in period t.

Taking the natural logs and differentiating the equation yields the following linear production functions:

$$y_{it} = lnA_{it} + \beta^{l}l_{it} + \beta^{k}k_{it} + \beta^{\mathrm{m}}\,\mathrm{M}_{it}$$

$$TFP_{it} = y_{it} - \beta^{l}l_{it} - \beta^{k}k^{it} - \beta^{\mathrm{m}}\,\mathrm{M}_{it}$$

Where, β^l, is the elasticity of labor, β^k is the elasticity of capital and β^m is considered as the elasticity of raw materials, are estimated using OLS, measured by Jefferson et al. (2008)

Here,

Yit= ln (sales),

Lit = ln (the number of employees)

Kit = ln (net fixed assets), and

Mit = ln (raw materials)

5. Data

5.1 Data Source & Sample Size

The food sector plays a crucial role in fostering the economic development of the country by producing and exporting food domestically and internationally. To assess the technological advancements in the Food & Allied industry, researchers have sought relevant data from the annual reports of companies listed on the Dhaka Stock Exchange (DSE) during the period from 2015 to 2021. However, it was not feasible to include all 21 listed companies in the industry due to the unavailability of the required annual reports. Some firms have only disclosed annual reports for two or three years on their websites. Additionally, five companies have no data available on their websites, and six companies have partial data that is insufficient for conducting the research. Moreover, some of these companies have dead links on their websites that do not function properly.

Ultimately, out of the 21 firms, data was collected from eight companies that were accessible over the period from 2015 to 2021. This resulted in the creation of a panel dataset comprising 56 observations. The necessary secondary information was gathered from company-audited annual reports, websites, the internet, and industry reports. Various statistical tools and software were employed to analyze and interpret the collected data.

5.2 Descriptive Statistics

Table 2 presents the descriptive statistics for both the dependent and independent variables. This table outlines the mean, standard deviation, minimum, and maximum values of the controlled and control variables for the period from 2015 to 2021. The average profitability,as measured by Return on Assets (ROA), is approximately 8%, while the mean risk stands at 8%. Firm age, growth, tangibility, and liquidity have average values of 3.52, 6%, 0.35 %, and 1.93 %, respectively. Moreover, the mean values for Total Factor Productivity (TFP) and net debt tax shield are 1.0772 and 8%. The standard deviation, minimum, and maximum values for TFP are 0.4406, 0.4719, and 2.4331, respectively. For ROA, the corresponding figures are 0.0757, -0.1459, and 0.2186.

Table 2. Summary Statistics of the Variables

Variables	Observation	Mean	Std. Dev.	Min	Max
risk	56	0.0809	0.1051	-0.0346	0.3770
Fage	56	3.5222	0.7171	1.9459	4.7095
Growth	56	0.0633	0.1639	-0.2843	0.4468
ROA	56	0.0797	0.0757	-0.1459	0.2186
Tangibility	56	0.3491	0.1512	0.0337	0.6276
Liquidity	56	1.9253	0.6064	1.2737	3.7341
Net Debt tax	56	0.0804	0.0758	0.003	0.2913
TFP	56	1.0772	0.4406	0.4719	2.4311

5.3 Results of Correlations

This research made a concerted effort to meet all the assumptions inherent in regression analysis, and the subsequent data analysis was conducted based on these considerations. It's important to note that additional analyses may be necessary after the regression analysis, particularly those related to the error term. In instances where a high correlation is present, the issue of multicollinearity can emerge.

Table 3. Pairwise Correlation between Independent Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) ROA	1.0000								
(2) TFP	0.3288	1.0000							
(3) LTD	0.0754	0.2314	1.0000						
(4) Fage	0.4030	0.4441	-0.5148	1.0000					
(5) Grow	0.1942	0.1964	0.3318	-0.0446	1.0000				
(6) Tang	-0.0338	0.0694	0.1272	-0.2673	0.1701	1.0000			
(7) Liquid	-0.1455	-0.4795	0.1316	-0.7103	0.0630	0.6321	1.0000		
(8) NDTX	0.4141	-0.3609	0.1091	-0.0913	0.1290	-0.4255	0.0688	1.0000	
(9) FSize	-0.1144	-0.1390	0.2955	-0.5274	0.1560	0.2984	0.3507	0.1138	1.0000

Table 3 illustrates the correlation levels between control variables and the proxy for profitability, ROA. The findings reveal a positive association between ROA and TFP (0.3288). Moreover, risk demonstrates a positive relationship with both ROA and TFP (0.0754, 0.2314), while firm age exhibits a positive correlation with both ROA and TFP (0.4030, 0.4441). Growth is positively correlated with ROA, TFP, and LTD (0.1942, 0.1964, and 0.3318). On the other hand, tangibility shows a negative relationship with both ROA and firm age (-0.0338, -0.2673), and liquidity demonstrates a negative association with ROA, TFP, and firm age (-0.1455, -0.4795, and -0.7103).

Non-debt tax shield is positively correlated with ROA, LTD, Growth, and liquidity (0.4141, 0.1091, 0.1290, and 0.0688), but exhibits a negative correlation with TFP, firm age, and tangibility (-0.3609, -0.0913, and -0.4255). Lastly, firm size shows a negative relationship with both ROA and TFP.

5.4 Regression Assumptions

Applying econometric analysis, we have analyzed the panel data to measure the contribution of technological effect on improving the financial value of the firm. At the very beginning of the analysis, we run pooled regression to find the impact of TFP on a firm's value improvement. In the next step, we run the Wald test and the Breusch-Pagan Lagrange Multiplier test (LM) to check out the robustness of the pooled regression model over the fixed effect, and random effect models. The analysis observed that both the fixed effect and random effect models are more appropriate than the pooled regression model. To select the more appropriate model between fixed and random effect model we apply Hausman (1978) test and the probability value of chi-square test (chi2 (8) = 44.36, 23.27)for both the dependent variable value of ROA (Prob >chi2 = 0.0000) and ROE (Prob >chi2 = 0.0030) are respectively (Prob>chi2 = 0.0000& 0.0030)indicate to reject the null hypothesis. Therefore, we opted for the fixed effect model is more suitable than the random effect model as there existsa correlation between error terms and explanatory variables.

The test result of the Variance Inflation Factor (VIF) is 4.40 indicating zero correlation between the independent variables. In the case of the post-estimation test modified Wald test was performed to check the group-wise heteroscedasticity in the residuals, the Chi-square value chi2 (8) for both ROA & ROE respectively 192.90 and 381.03 with probability values for both the dependent variable 0.0000.The study also finds the value of the Wooldridge test to investigate serial correlation in the panel data, and the value of F(1, 7) statistic to identify autocorrelation for both the dependent variable ROA and ROE with a probability value of 0.2844 and 0.02614 respectively. Again, the presence of units in most of the variables declares that the variables in the regression were not co-integrated. To rectify the problem of heteroscedasticity, and autocorrelation in the used panel data set we decided to apply panel corrected standard regression model.

5.5 Panel Correlated Standard Errors Regression Model

The econometric analysis finds heteroscedasticity, autocorrelation, contemporaneous correlation, and nonstationary problems in the regression model. Thus, to fix the problem in the econometric model the study employed panel-correlated standard errors (PCSE) to estimate panel data. The PCSE model considers that there exists a correlation among the errors and the error terms are heteroscedastic and contemporaneously correlated across panels.

Table 4. Regression Results of the Panel Corrected Standard Regression

	ROA			ROE		
Variable	**OLS**	**FE**	**PCSE**	**OLS**	**FE**	**PCSE**
TFP	.058**	0.054	.046*	0.107	0.214	0.083
	-0.025	-0.048	-0.028	-0.068	-0.137	-0.073
FSize	0.001	-0.06	-0.001	-0.004	-.186*	-0.012
	-0.004	-0.037	-0.005	-0.011	-0.106	-0.013
NDTS	.58***	1.407***	.445***	.77*	-4.344***	0.296
	-0.148	-0.348	-0.158	-0.398	-1.002	-0.443
Liquidity	.058*	0.015	.057***	0.138	0.04	.148***
	-0.033	-0.031	-0.021	-0.089	-0.089	-0.053
Tangibility	0.038	0.165	0.027	-0.135	0.489	-0.199
	-0.105	-0.279	-0.07	-0.282	-0.803	-0.174
Growth	-0.027	-0.018	-0.01	-0.096	-0.069	-0.037
	-0.047	-0.036	-0.05	-0.125	-0.103	-0.132
FAge	.088***	-0.003	.085***	.177**	0.024	.172***
	-0.028	-0.055	-0.023	-0.075	-0.159	-0.059
risk	.215*	0.078	.245**	.736**	0.449	.834***
	-0.122	-0.24	-0.098	-0.326	-0.691	-0.273
_cons	-.505***	1.259*	-.427**	-.846*	3.637*	-0.604
	-0.177	-0.703	-0.178	-0.476	-2.023	-0.451
Observations	56	56	56	56	56	56
R-squared	0.623	0.33	0.5	0.443	0.379	0.424

In the above table, we considered ROA & ROE as the dependent variable and TFP, risk, Fage, FSize, liquidity, tangibility NDTS as our independent variables. The regression results of the PCSE model reveal that TFP is significant at a 1% level of significance for model 1 only (ROA). The coefficient of CSR is 0.046 indicates that TFP acts positively on a firm's economic performance. Thus, if the firms contribute more to improving their technological advancement it will impact positively on improving ROA. In the case of model 1, the study finds that NDTS, liquidity, Fage and risk have significant contributions to enhancing the firm progress ROA. Further in the PCSE analysis of model 2, the study finds different results. The regression results of model 2 find that TFP does not influence improving the ROE of firms. For model 2liquidity, Fage and risk act positively to improve the value of ROE.

6. Discussion

The research conducted by Dvoulety & Blazkova (2022) underscores the significant dependence of firm performance on Total Factor Productivity (TFP), aligning with their study's conclusions. Interestingly, the positive impact of Non-Debt Tax Shields (NDTS) on firm performance contradicts the findings of Vinasithambysritharan (2015). This deviation is noteworthy as Vinasithambysritharan found no such positive association.

In contrast to the research by Zahoor & Huma (2015), which suggested a negative relationship between risk and firm performance, the current study indicates a positive correlation. This discrepancy highlights a departure from the established findings of Zahoor & Huma. On the topic of liquidity, the research by Asif & Murad (2019) reveals a robust positive impact on Return on Assets (ROA), consistent with their findings. This aligns with

the notion that liquidity plays a crucial role in influencing firm performance.

The positive relationship observed between firm size and firm performance contradicts the conclusions drawn by Meiryani & Sudrajat (2020), who did not find such a consistent association. This inconsistency underscores the complexity of the relationship between firm size and performance. Finally, the positive impact of tangibility on firm performance, in line with the findings of Itlas (2010), supports the notion that tangible assets contribute positively to a company's overall performance.

Table 5. Overview of the findings

Dependent variable	Explanatory variables	Relationship	Comparison with previous studies
ROA & ROE	TFP	Positive	Consistent with Dvoulety, O. and Blazkova,I. (2022)
	risk	Positive	Inconsistent with Zahoor & Huma, (2015)
	Fsize	Positive	Inconsistent with Meiryani & Sudrajat, J. (2020)
	Liquidity	Positive	Consistent with Asif & Murad, 2019
	Net Debt Tax Shield	Positive	Incompatible with vinasithambysritharan, (2015)
	Tangibility	positive	Compitable with Itlas, Y. (2010)

7. Concluding Remarks

The overall research is done on the Food & Allied companies listed on the Dhaka Stock Exchange (DSE) considering the data from 2015-2021. The core objective was to find out the influence of technology on its performance indicator ROA. In order to conduct this research, the data of 8 companies from 2015-2021 has been taken into consideration. The study used ROA and ROE as dependent variables, where to find out the determinants of ROA the study has taken tangibility, liquidity, firm size, growth, long-term leverage ratio and net debt tax shield as explanatory variables. Cobb Douglas production function as well as the multiple regression models has been used to shape the equation. To analyze the data Stata and Excel software both have been used. The outcome of the paper notifies that there exists statistically a significant relation between ROA and Technology Advancement. ROA has also a statistical relationship with NDTS, Fage, tangibility, liquidity, and risk. Again, the study shows that there exists no statistical relationship between ROA with the variable's growth and FSize. In case of ROE the study didn't find and significant link with firm performance. Finally, this study recommends that firm performance has a notable impact on the investment in technology. Hence, the research recommends an increased emphasis on technological investment and research to enhance the economic value of firms within the Food and Allied sector as investing in technology also presents a strategic advantage. Embracing technological advancements can lead to improved operational efficiency, innovation, and market competitiveness, thereby fostering sustained economic growth for companies in the food and allied industries. By channeling resources into technology-driven initiatives, firms have the potential to capitalize on emerging opportunities and ultimately position themselves for long-term success in the dynamic business landscape.

8. Scope of Further Study

Additional research could enhance the understanding of Return on Assets (ROA) in Food and Allied companies in Bangladesh by incorporating more variables such as non-debt tax shields, risk of bankruptcy, and various corporate governance indicators like CEO duality, ownership structure, board size, and non-executive structure. Utilizing advanced econometric techniques could provide a more nuanced measurement of firm performance in the near future. This study also presents an opportunity to replicate the methodology for other industries in Bangladesh, such as textile, fuel, tannery, and pharmaceutical companies. As more annual reports and updated data become available for the remaining 13 companies, conducting further studies could yield valuable insights. Additionally, exploring the impact of technology on firm performance, considering both Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE) listed food and allied companies, would be a significant endeavour. This expanded research could contribute to a comprehensive understanding of the factors influencing the performance of companies in the mentioned industries in Bangladesh.

Acknowledgements

We thoroughly value the collaborative effort put forth in teamwork, encompassing the development of the conceptual framework, the meticulous process of data collection, and the intricate editing phases leading to the preparation of the manuscript for the article. Our appreciation extends to the collective contributions of the team members, highlighting the synergy that has enriched the overall collaboration and acknowledging each individual's valuable input.

Author’s contributions

Kawsar Jahan, an Associate Professor and the corresponding author, spearheaded the development of the research topic, conducted data analysis, and composed the abstract, research methodology, and conclusion sections of the paper. Professor Tanzina Haque, the first co-author, contributed to shaping the conceptual framework and crafting the introduction of the article. The second co-author, Md. Sohanul Islam, played a crucial role in the data collection process and took charge of formulating the literature review, discussion and in including the references sections. Each author independently drafted their assigned portions, and the collaborative effort involved revising the manuscript collectively. The final version underwent thorough review and approval by all authors.

Funding

There is no need for financial assistance in the data collection process. The data was gathered from food and allied companies listed on the Dhaka Stock Exchange.

Competing interests

We affirm that we have no financial interests or personal relationships that might be perceived as influencing the work presented in this paper. Our involvement is entirely driven by research and academic purposes.

Informed consent

Obtained

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhereto the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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Appendix

Table 6. Variation Inflation Factors (VIFs)

Variable	VIF	1/VIF
Liquidity	8.78	0.113897
Firm age	8.70	0.114965
Tangibility	5.50	0.181949
Long term debt	3.56	0.280789
Net Debt Tax	2.76	0.362259
TFP	2.73	0.366163
Firm Size	1.90	0.526008
Growth	1.27	0.787220
Mean VIF	4.40	