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A Neural Network Analysis of Accounting Variables and Stock Price: The Case of Real Estate Companies in the Philippines

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ABSTRACT
This research examines the importance of various accounting variables in predicting stock price changes for the top three real estate companies on the 2024 Philippine Stock Exchange. Using artificial neural network (ANN) analysis, the study focuses on the current ratio, return on assets, return on equity, net profit margin, operating profit margin, and debt-to-equity ratio. Quarterly financial reports and stock prices from 2018 to 2023 were analyzed with a feedforward back-propagation ANN model in SPSS 25. Results show that the net profit margin is the most significant predictor of stock prices, highlighting profitability as crucial. The operating profit margin is particularly important for Mega World Corporation, while the current ratio is critical for SM Prime Holdings. The debt-to-equity ratio is moderately important across all companies. These findings emphasize the varied impact of profitability, operational efficiency, leverage, and liquidity on stock prices, aiding investment decisions and strategic planning.

Keywords:
Neural Networks; Accounting Variables; Stock Price; Real Estate Companies; Philippines

INTRODUCTION

The Philippine real estate sector stands as a cornerstone of the nation's economic landscape, exhibiting resilience and growth despite various economic challenges and global uncertainties. Data from the Philippine Statistics Authority (2023) shows that headline inflation rose slightly from 8.0 percent in November 2022 to 8.1 percent in December 2022, impacting the housing sector with a 6.4% markup. Additionally, Bangko Sentral ng Pilipinas (2023) forecasts a 25-50 base point increase in interest rates (Villanueva, 2023), making borrowing more challenging. Despite these hurdles, industry experts view the real estate market favorably, recommending Real Estate Investment Trusts (REITs) and property investments over stocks as a more stable option (Fulgar, 2023).

As the sector continues to play a pivotal role in the Philippine economy, it is imperative to scrutinize the factors that underpin stock price fluctuations within this dynamic industry. Aside from the commonly studied variables such as inflation, exchange rates, industrial productivity, interest rates, money supply and short-term interest rates which empirical studies on these variables continue to give divergent results from one market to another and even over different time periods in the same market (Mumo, 2017), investors, both domestic and international, are keen to identify other reliable indicators that can guide their investment decisions in a climate of heightened uncertainty.

One such set of indicators that has long been regarded as fundamental to assessing a company's financial health and, consequently, its stock performance, is accounting variables. These variables encompass an array of financial metrics and performance measures, including earnings per share (EPS), price-to-earnings (P/E) ratios, debt-to-equity ratios, and net income. They serve as vital signals, offering investors a glimpse into the financial standing and operational efficiency of a company. Accounting variables, when properly understood and interpreted, can assist investors

in making informed decisions (Blessing and Onoja, 2015), allowing them to gauge the potential risks and rewards associated with a particular investment.

As asserted by Brigham and Houston (2013), analysis of these accounting variables or also known as financial ratios of financial statements facilitates an assessment of past management achievements and future prospects. The results of the analysis of these financial ratios, according to Kodithuwakku (2016), can be used by internal parties for future planning endeavors and by external parties, such as creditors or suppliers, in evaluating a company's creditworthiness or its ability to meet financial obligations. Moreover, it can provide information that are: (1) useful for investment and credit decision-making; (2) assist in forecasting future cash flows; and (3) serve to delineate economic resources, liabilities, and changes therein (Szydelko and Biadacz, 2016).

These accounting variables can be made to forecast Stock price of real estate for the next several periods using machine learning techniques. Given that these variables may not exhibit linear relationships, this study employed Artificial Neural Network (ANN) (Fitriani, Ispriyanti, & Prahutama, 2015), which is adept at handling nonlinear forecasting problems. This system works like the human brain to carry out complex calculations (Susilokarti, Arif, Susanto, & Sutiarso, 2015). This approach can learn intricate linear and nonlinear relationships between predictors and adoption decisions (Chan & Chong, 2012). Moreover, ANNs are more robust and offer higher prediction accuracy compared to linear models (Tan, Ooi, Leong et al., 2014), and can outperform traditional statistical methods like MRA (Chong, 2013a; Sim et al., 2014).

The significance of accounting variables as predictors of stock price changes within the Philippine real estate sector is crucial due to the sector's vulnerability to economic shifts and regulatory changes. By understanding which accounting variables most influence stock prices, investors can make more informed decisions, enhancing their ability to navigate the market effectively and maximize returns. For policymakers, insights into how these accounting variables drive stock price changes are invaluable. They provide a deeper understanding of the sector's financial health and stability, which is essential for crafting policies that foster a robust and resilient financial ecosystem. Policymakers can use this knowledge to anticipate potential market disruptions and implement measures that mitigate risks, ensuring the sector's continued growth and stability. Accurate predictions based on accounting variables can guide central banks and economic decision-makers in formulating effective monetary and fiscal policies. Overall, the ability to predict stock price changes based on accounting variables supports investment, consumption, and saving decisions. This, in turn, contributes to broader economic stability by ensuring that resources are allocated efficiently, and that the financial system remains resilient to shocks. By aligning policies with these insights, policymakers can promote an environment conducive to long-term economic growth and stability, ultimately benefiting the entire economy (Nyoni, 2019).

The main goal of this research is to provide insights into the relative importance of various accounting variables in explaining stock price changes in the top 3 real estate companies listed on the Philippine Stock Exchange (2023) using an artificial neural network analysis. The study focused on these major companies: Mega World Corporation (MEG), SM Prime Holdings (SMPH) and Ayala Land Inc. (ALI) because their stock performance is important to investors, analysts, and policymakers. By examining this specific part of the Philippine stock market, the research aimed to

provide insights that can guide investment decisions, improve financial knowledge, and enhance understanding of stock market behavior in the country's real estate sector. This study is particularly relevant given the current economic challenges and global uncertainties, making it a valuable resource for stakeholders in the Philippine real estate industry and contributing to the wider discussion on stock market dynamics in a constantly changing financial environment.

Literature Review

Empirical studies conducted in various countries have sought to discern the factors that influence the stock prices. Past research by Menike and Prabath (2014) showed Dividend Per Share (DPS), Earnings Per Share (EPS), and Book Value Per Share (BVPS) as influential factors affecting stock prices of 100 companies listed in the Colombo Stock Exchange (CSE) between 2008 to 2012. Multiple regression analysis revealed that these variables exhibit significant and positive impacts on stock prices, with DPS demonstrating the highest sensitivity.

Similarly, Asif (2016) examined the relationship between accounting information and share price by developing a model encompassing key accounting ratios such as EPS, BVPS, Capital Employed Per Share, and Operating Cash Flow Per Share. Analyzing data from companies listed in the Pakistan Stock Exchange from 2006 to 2013, using the OLS regression models, reveal that the EPS, BVPS, and Operating Cash Flow have significant influences on share price. These results align with the results in the previous empirical researches carried out in several stock markets of developed and developing countries

Furthermore, Hassan and Haque (2017) explored the relationship between share prices and the value-relevance of accounting information, using the basic Ohlson (1995) valuation model on 93 companies from six broad industries listed in the Dhaka Stock Exchange (DSE), Bangladesh. Results showed that both EPS and BPVS have an influential role in determining share prices. However, results on their individual effects further showed that the EPS played an increasingly considerable role in projecting share prices than that of BV. Thus, EPS has become more informative to equity investors in predicting the share prices.

Extending the examination to real estate companies, Dwiyanthi, et al. (2021) studied the impact of financial ratios on stock prices in eight (8) property real estate companies in the construction and building sector listed in the Indonesia Stock Exchange (IDX) from 2016-2019. The financial ratios studied were Current Ratio (CR), Return on Assets (ROA), Return on Equity (ROE), Net Profit Margin (NPM), and Operating Profit Margin (OPM) can affect stock prices in the said companies. Through multiple linear regression analysis, they discovered that while ROA and ROE have significant effects on stock prices, CR, NPM, and OPM exhibited no significant effects, consistent with prior research findings.

Additionally, Ratnasih and Zulher (2021) studied the influence of Price Earnings (PE) Ratio, Debt to Equity (DE) Ratio, and Return on Assets (ROA) on stock prices in the real estate companies in IDX. Their multiple regression analysis revealed that PE Ratio, DE Ratio, and ROA simultaneously have significant effects on real estate stock prices. Furthermore, Tangngisalu (2022) investigated the effects of CR, ROA, and Debt to Equity Ratio (DER) using multiple regression analysis to determine whether these affect the stock price of the property and real estate companies listed in the IDX. Their findings indicated that ROA had a positive significant effect, CR exhibited a negative significant effect, while DER remained insignificant.

METHOD

1. Data Source

Data for this study was collected from the Philippine Stock Exchange (2024) website, which included financial reports, stock price data, and economic indicators. The dataset encompassed quarterly historical financial statements and stock price figures for the top 3 Philippine indexed real estate companies over the period from 2018 up to the end of the third quarter of 2023. The dataset included: (1) Financial Statements: Historical financial reports, including balance sheets, income statements, and cash flow statements, were obtained from corporate filings, annual reports, and financial databases. These reports provided essential accounting variables such as earnings per share (EPS), net income, debt-to-equity ratios, and price-to-earnings (P/E) ratios; and (2) Stock Price Data: Periodic stock price data for the selected real estate companies.

2. Artificial Neural Network (ANN) Analysis

Artificial Neural Network (ANN) is an advanced machine learning technique, modelled after the human brain that can capture complex relationships within data. ANN is often used in dynamic time sequence systems that are nonlinear on a large scale consisting of many processing elements connected in parallel. A typical ANN consists of several hierarchical layers: the input layer, hidden layer, and output layer (Purbasari, Anggraend and Ardiningrum, 2020). Each layer consists of neurons, which relate to the neurons of the following layer and each connection is represented by an adaptable synaptic weight. With one hidden layer, any continuous function can be represented, while with two hidden layers even discontinuous functions can be modelled (Negnevitsky, 2011). The working of ANN follows a node with weighted sum of inputs, then summed to a bias value, and passed through an activation function (non-linear function). The result that is output of this node becomes the input of node in the next layer. It continues in a chain fashion and then the final output is retrieved after the result travelled the intermediate hidden layers (Hota and Dash, 2021).

The number of neurons in the input layer is equal to the number of inputs, i.e. predictors, while the number of neurons in the output layer is equal to the number of outputs, i.e. dependent variables. The number of hidden layers depends on the complexity of the problem to be solved (Liébana-Cabanillas, Marinkovic, Zoran Kalinic, 2017). As suggested by Gnana Sheela & Deepa (2013), the number of hidden neurons also depends on the number of both input and output neurons.

In this study, the ANN was modeled in SPSS 25 using the feedforward back-propagation multilayer perceptron (MLP) (Chong, Liu, Luo, & Ooi, 2015; Huang, 2010; Negnevitsky, 2011). A perceptron algorithm is based on binary classifiers, that takes an input signal and provides an output signal after processing or computation, basically a single-layered neural network. The input layer resembles the dendrites of the neuron and output signals the axon. The input signals are assigned weights which are multiplied by input values, and the weighted sum of all inputs are stored in the neuron. The computation of the weights is done by gradient decent and back-propagation algorithms, these adjust the free parameters to minimize the loss/cost function. Back-propagation models are generally used in training of Feed-Forward Neural network (Hota and Dash, 2021). The ANN schematic structure in this study is shown in Figure 1.

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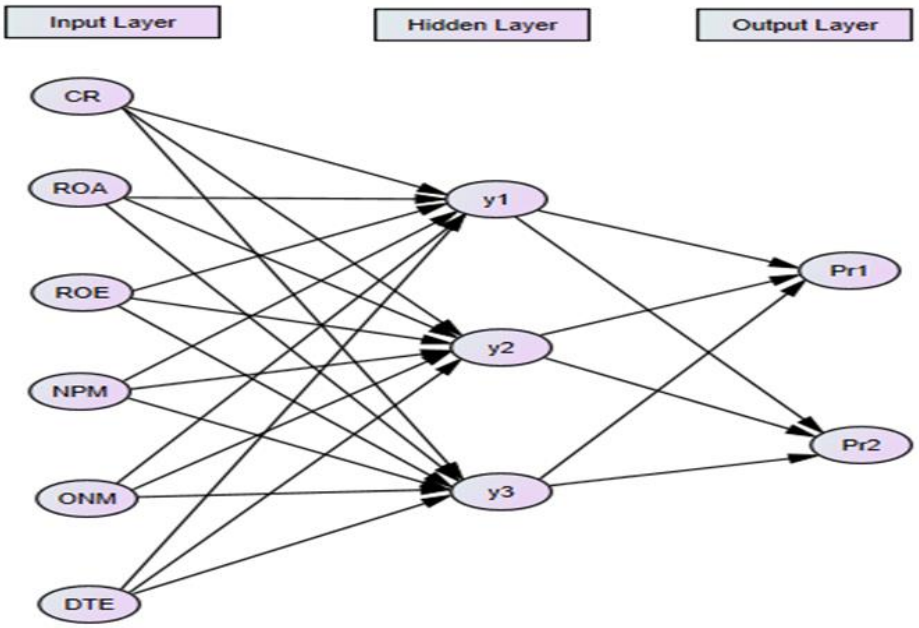

Figure 1. Schematic Structure of ANN for Accounting Variables and Stock Price

The Neural Network model of this study consists of 6 accounting variables in the input layer, i.e. current ratio (CR), returns on asset (ROA), return on equity (ROE), net profit margin (NPM), operating net margin (ONM), and debt-to-equity ratio (DTE) while the output layer comprises of 2 stock price changes (i.e. Price changes in one month (Pr1) and in two months (Pr2) after release of financial reports within the real estate sector. On the other hand, the number of nodes in one hidden layer is set to 3 (y1, y2, y3) in accordance to Shibata and Ikeda (2009), Yao, Tan, and Poh (1999) and Panahian (2011), suggesting that the number of hidden neurons m could be calculated as follows: m = square root of $(n \cdot l)$, where n is the number of input neurons and l is the number of output neurons. Both the hidden and output layers used sigmoid function as its activation function for the neurons (Chan & Chong, 2012; Leong et al., 2013). To measure the prediction accuracy of the trained network, a ten-fold run of ANN was performed for the data set of each real estate company which was divided into two phases: 90% for the training and 10% for the Testing (Chong et al., 2015; Chong, 2013a; Chong, 2013b; Leong et al., 2013; Sim et al., 2014; Tan, Ooi, Leong et al., 2014; Liébana-Cabanillas, Marinkovic, Zoran Kalinic, 2017). Additionally, the Root Mean Square of Error (RMSE) was utilized to assess the predictive accuracy of the model in both training and testing data sets for all ten neural networks in each real estate company.

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RESULTS AND DISCUSSION

1. Neural Networks Root Mean Square Error Values

Table 1. Root Mean Square Error (RMSE) Values for the Neural Networks

Neural Network	MEG		SMPH		ALI	
	Training	Testing	Training	Testing	Training	Testing
ANN1	0.23	0.19	0.26	0.43	0.22	0.27
ANN2	0.21	0.27	0.22	0.23	0.14	0.25
ANN3	0.24	0.25	0.21	0.16	0.25	0.20
ANN4	0.26	0.16	0.24	0.26	0.25	0.07
ANN5	0.25	0.19	0.23	0.25	0.21	0.32
ANN6	0.20	0.04	0.18	0.08	0.19	0.32
ANN7	0.18	0.28	0.24	0.19	0.25	0.16
ANN8	0.24	0.31	0.24	0.23	0.13	0.06
ANN9	0.24	0.34	0.20	0.43	0.17	0.30
ANN10	0.25	0.07	0.20	0.15	0.25	0.14
Mean	0.23	0.21	0.22	0.24	0.21	0.21
SD	0.02	0.10	0.02	0.11	0.05	0.10

Source: Data Analysis, 2024

The Root Mean Square Error (RMSE) values for different Artificial Neural Networks (ANNs) across training and testing phases for the top 3 real estate companies listed on the Philippine Stock Exchange: Mega World Corporation (MEG), SM Prime Holdings (SMPH), and Ayala Land Inc. (ALI) are presented in Table 1.

The RMSE values show that the Artificial Neural Networks (ANNs) used in the study perform consistently well, with low standard deviation during training for the top three real estate companies on the Philippine Stock Exchange (MEG, SMPH, and ALI). This suggests that the models learn and generalize well within the training data. The testing phase RMSE values, ranging from 0.21 to 0.24, reflect reasonable prediction accuracy and indicate that the models do not overfit the training data. The close RMSE values for both training and testing phases across all companies highlight the ANNs' effectiveness in predicting stock price changes based on accounting variables, demonstrating their strong and reliable performance.

2. Accounting Variables Importance

Table 2. Absolute and Normalized Importance of the Accounting Variables

Predictors	MEG		SMPH		ALI	
	Importance	Normalized Importance	Importance	Normalized Importance	Importance	Normalized Importance
Current Ratio	0.13	0.62	0.22	0.94	0.13	0.51
Return on Assets	0.16	0.77	0.11	0.45	0.14	0.53
Return on Equity	0.16	0.79	0.16	0.70	0.14	0.55
Net Profit Margin	0.19	0.93	0.23	1.00	0.26	1.00
Operating Profit Margin	0.21	1.00	0.12	0.51	0.16	0.65
Debt to Equity	0.16	0.76	0.15	0.65	0.17	0.68

Source: Data Analysis, 2024

The absolute and normalized importance of the accounting variables as predictors of stock price changes for the three companies (MEG, SMPH, and ALI) were examined and are presented in Table 2.

For MEG, the most important predictor of stock prices is the Operating Profit Margin, with a normalized importance of 1.00. The Net Profit Margin is also significant, with a normalized importance of 0.93, while the Current Ratio is the least important predictor, with a normalized importance of 0.62. For SMPH, the Net Profit Margin is the most crucial predictor, with a normalized importance of 1.00, followed closely by the Current Ratio, which has a normalized importance of 0.94. The Return on Assets is the least important predictor for SMPH, with a normalized importance of 0.45. For ALI, the Net Profit Margin again stands out as the most important predictor, with a normalized importance of 1.00. The Debt-to-Equity ratio is also significant, with a normalized importance of 0.68, whereas the Current Ratio is the least important predictor, with a normalized importance of 0.51.

Overall, among the six accounting variables, the net profit margin stands out as the most important predictor for all three companies, highlighting profitability as a key driver of stock prices in the real estate sector. Additionally, the operating profit margin is particularly important for MEG, suggesting that operational efficiency is more critical for this company compared to SMPH and ALI. The debt-to-equity ratio is moderately important across all companies, emphasizing the role of leverage in stock price determination. Conversely, the current ratio is more important for SMPH than for MEG and ALI, indicating that liquidity is more crucial for SMPH. These insights clarify which accounting variables most influence stock prices for each company, aiding in investment decisions and strategic planning.

Discussion

For MEG, the Operating Profit Margin emerges as the most crucial predictor of stock prices. This highlights the significance of operational efficiency in driving MEG's stock performance. Investors are likely to view efficient operations as indicative of effective management and sustainable profitability. The Net Profit Margin also plays a significant role, reinforcing the importance of overall profitability. Interestingly, the Current Ratio, which measures liquidity, is the least important predictor for MEG. This suggests that investors may not be as concerned with MEG's short-term liquidity as they are with its ability to generate profits and manage operations efficiently.

In contrast, for SMPH, the Net Profit Margin is the most critical predictor of stock prices. This underscores the paramount importance of profitability in influencing SMPH's stock performance. Following closely is the Current Ratio, indicating that liquidity is also a significant concern for investors. This may be due to the company's need to maintain a strong cash position to support its extensive property development projects. The Return on Assets, is the least important predictor for SMPH, suggesting that the efficiency with which assets are used to generate earnings is less of a focus for investors compared to overall profitability and liquidity.

For ALI, the Net Profit Margin once again stands out as the most important predictor, emphasizing profitability as a key driver of stock prices. The Debt-to-Equity ratio, is also significant, reflecting the importance of leverage in the company's financial structure. This indicates that investors pay attention to how effectively ALI manages its debt in relation to its equity, as high leverage can amplify both gains and risks. The Current Ratio is the least important predictor for ALI, suggesting that liquidity concerns are less critical for investors in this company compared to profitability and leverage.

The findings of the study, emphasizing the importance of profitability measures, such as the Net Profit Margin, support Agency Theory. This suggests that managers

are incentivized to maximize profitability to align their interests with those of shareholders, as higher profitability directly influences stock prices. Additionally, the results align with Signaling Theory, where the significant role of profitability ratios demonstrates their effectiveness as signals to investors about a company's performance and future prospects. High Net Profit Margins send positive signals, bolstering investor confidence and driving stock prices. Furthermore, the varying importance of different financial metrics across companies supports Stakeholder Theory, indicating that different stakeholders (e.g., investors, creditors) prioritize various aspects of financial health depending on the company.

CONCLUSION

Across all three companies, the Net Profit Margin consistently stands out as the most important predictor of stock prices, highlighting profitability as a key concern for investors in the real estate sector. The importance of the Current Ratio for SMPH indicates that liquidity is a significant factor for investors, likely due to the capital-intensive nature of real estate development. The Debt-to-Equity ratio's significance for ALI shows that how a company manages its debt relative to its equity is an important consideration for investors, reflecting concerns about financial stability and risk.

Investors should prioritize profitability measures, particularly the Net Profit Margin, when evaluating real estate companies. For MEG, operational efficiency should also be a key consideration. For SMPH, liquidity metrics are crucial, while for ALI, attention should be given to leverage ratios alongside profitability. Moreover, companies should emphasize clear and detailed reporting of profitability and efficiency metrics. Transparent reporting of these key indicators can enhance investor confidence and positively impact stock prices.

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