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Portfolio Selection: Micro and Macro Analysis of the Philippine Stock Market Using AHP and FTS-MC

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Abstract We have seen rapid development in financial stocks over the past decades, but variabilities in share price behavior remain due to micro and macroeconomic variables. This study examined the Philippine stock market from micro and macro perspectives in performing the following tasks: (1) Identify the top-performing industry and consider its top companies as an investment pool using AHP – analytic hierarchy processes; (2) Forecast future stock prices based on historical behavior utilizing FTS–MC – Fuzzy Time Series Markov Chain Model; (3) Present a portfolio selection framework considering an EWP – equally weighted portfolio strategy. These resulted in the following: (1) Property identified as the best industry; (2) Stock prices being accurately predicted; and (3) EWP portfolio that outperforms the benchmark (Philippine Stock Exchange). Hence, applying AHP in investment pool screening, FTS-MC in forecasting price movement, and EWP portfolio strategy can be a worthy investment framework.

Keywords: • stock market • AHP • markov analysis • FTS–MC • portfolio selection

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1 Introduction

The last few decades have witnessed rapid development in business and finance. The increased openness among nations resulted in a closer interconnection between economies, giving rise to financial integration (Dias et al., 2020; Raddant & Kenett, 2021). The established link between neighboring countries led to the advancement of financial markets. Generally, it is an excellent economic and investment platform. Among the assets that different entities could exchange in the financial market include the portions of a given company, commonly known as stocks. Purchasing a specific number of stocks grants holders an equivalent percentage of business ownership; they would become eligible for voting rights and part of the enterprise's profit (Bhandarkar et al., 2019). These gains benefit the venturers as they can have a large sum of money within a limited period.

On the other hand, the stock investment could also be advantageous based on the company's perspective. Firms that offer their shares to the public let them generate funds and raise capital; this situation could pave the way for expansion (Gautami & Kalyan, 2018). Most importantly, the advantages of stocks mentioned above are of a wide range because these are visible in many areas (Shah et al., 2019). While several studies have proven the benefits of stock investment to shareholders and enterprises, these advantages may still correspond to certain risks and uncertainties. Although this venture is profitable, it is hard to forecast and anticipate share price behavior (Badri et al., 2022). In turn, the instability in stocks could affect investor confidence and risk-taking tendencies (Kuhnen & Knutson, 2011). In addition, not all investors exhibit rational behavior (Chang et al., 2018). These attitudes attest that many investors lack proper knowledge of the stock market behavior, affecting their logical decision-making.

The stock market has been observed globally in response to this financial attitude. Researchers studied the financial market and monitored its uncertain behavior to support investment decisions. Theoretically, microeconomic and macroeconomic variables influence the variability in share prices (Rjoub et al., 2017). From a micro viewpoint, stock price uncertainties are influenced by the firm's profitability, efficiency, and ability to meet obligations (Prazak & Stavarek, 2017). With this, stock market studies often examine the firms' economic situation and use financial ratios to represent characteristics associated with price behavior (Jermsittiparsert et al., 2019; Musallam, 2018; Roodposhti et al., 2018). Furthermore, stock selection strategies have been prevalent in evaluating performance metrics by applying a multi-criteria decision approach, wherein standard methods included Analytic Hierarchy Processes (AHP) (Guo & Zhang, 2010).

Apart from microeconomic factors, the stock market behavior is influenced by various macroeconomic variables (Adesokan, 2018; Khan & Yousuf, 2013; Kavitha et al., 2013; Osamwonyi & Evbayiro-Osagie, 2012). Unfortunately, these outcomes are also evident

in developing countries like the Philippines, where the stock market is still emerging. The effects of macroeconomic variables on stocks are uncontrollable since the said factors govern the domestic economy (Lakmali & Madhusanka, 2015). Given this, individual firms might be unable to manage them easily (Sutrisno, 2017). Because of the stock's unforeseeable instability, the venture's success depends solely on investors' decisions and knowledge of share price movement. Thus, extensive stock selection and multi-criteria decision analysis might not be efficient; sophisticated optimization techniques must be simultaneously implemented. Since the stock price movement is stochastic, its behavior exhibits Markovian properties (Sultan et al., 2019). Therefore, studies have applied Markov chain theory to analyze such situations for studying stochastic processes; researchers also considered it a modern optimization and forecasting tool (Jannah & Fatekurohman, 2022). In terms of stock market research, the said tool provides more accurate results than other traditional forecasting techniques as it accounts for daily stock fluctuations (Vasanthi et al., 2011). In the Philippine setting, the Philippine Stock Exchange (PSE) classifies its firms into six sectors: Financials, Industrials, Holding Firms, Property, Services, and Mining and Oil. The country's stock market has continuously emerged as a field. While it has expanded domestically and internationally, its stock behavior remained sensitive to political and economic conditions (Bautista, 2003).

Previous studies have incorporated microeconomic or macroeconomic analysis in stocks. However, these papers have only used such tools to describe and evaluate the stock market. There remained a paucity of literature proving the efficiency of using techniques such as AHP and Markov Analysis simultaneously to generate a good investment pool and support investment decisions. Most significantly, stochastic studies have not been widely applied in the Philippines; these few papers have not even focused on evaluating a specific PSE industry as they were centered only on the stock market index in general. To cite examples, Cantuba et al. (2016) used the tool to forecast the Philippine Stock Exchange (PSE) prices and concluded an excellent forecasting performance for the Markov model. Identically, Almonares (2019) applied a two-state Markov switching analysis to observe the PSE monthly returns.

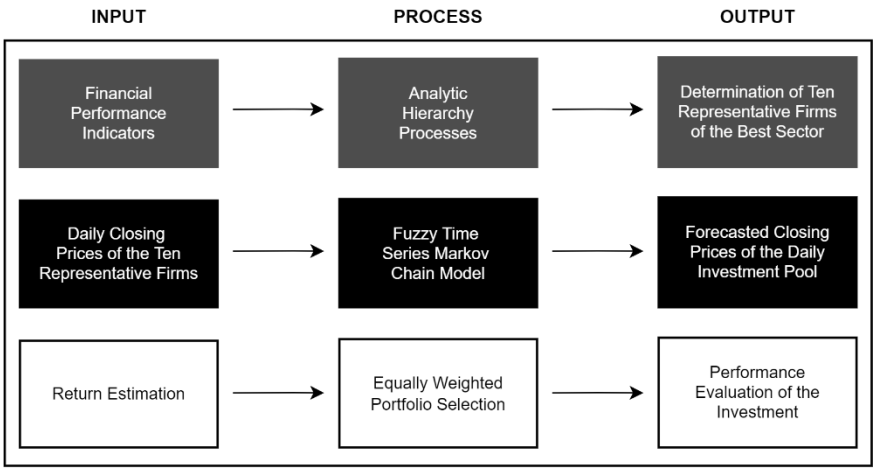
The present research addressed this gap by studying the Philippine stock market from micro and macroeconomic perspectives. From a microeconomic scope, the researcher chose a pool of representative companies from a particular industry based on the top-ranking sector by performance. From a macroeconomic viewpoint, this study forecasted future stock price movements based on their historical behavior. Finally, this research presented a portfolio selection model of the generated investment pool. The study is significant in various aspects as its findings benefit the enterprises, investors, and the academe.

2 Methodology

2.1 Conceptual Framework

The study applied a quantitative research approach and adopted a descriptive research design. This research was guided through the conceptual framework in Figure 1, showing the microeconomic and macroeconomic scope of the research analysis. Specifically, AHP was utilized to determine the best sector and choose representative firms under the top industry. Meanwhile, the study used Fuzzy Time Series Markov Chain Model (FTS–MC) to forecast closing prices and select the daily pool. Lastly, the researchers employed an equally weighted portfolio selection strategy to evaluate the performance of the generated investment pool with respect to the market.

Figure 1: Conceptual Framework



2.2 Data Collection

Three primary data were gathered in line with the study's objectives. The AHP multi-criteria decision tool required the criteria's importance weights and financial performance indicators for the microeconomic analysis. The pairwise importance ratings among the requirements were collected from survey responses distributed to 207 existing and potential investors. In addition, thirteen (13) accounting titles under 251 PSE company's financial reports, dated 31st December 2021, were gathered to serve as the performance indicators. These data included current assets, current liabilities, total assets, total equity, book value per share, current and previous sales, current and last net income, current and prior earnings per share, and share price. Meanwhile, the macroeconomic analysis

focused on the stock market's historical data. Thus, the daily closing prices of ten selected firms under the chosen industry were collected from 4th January 2016 to 29th December 2021.

2.3 Data Analysis

2.3.1 Financial Ratios as Performance Indicators

The present study conducted a preliminary analysis among the PSE sectors, including Financials, Industrials, Holding Firms, Property, Services, and Mining & Oil. For this objective, selected financial ratios were used to evaluate the performance and characteristics of the publicly listed companies. The study collected each firm's latest available data, wherein these accounting titles were utilized in calculating the different financial ratios shown in Table 1.

Table 1: Financial Ratios Formulas

Ratio	Meaning	Formula	Reference
Liquidity Ratios			
Current Ratio	Ability to pay short-term obligations	$\frac{\text{Current Assets}}{\text{Current Liabilities}}$	Gitman et al. (2015); Jermsittiparsert et al. (2019); Prazak & Stavarek (2017)
Quick Ratio	Ability to pay short-term obligations with the most liquid asset	$\frac{\text{*Cash} + \text{*Receivables} + \text{*Short-term Investments} + \text{*Marketable Securities}}{\text{Current Liabilities}}$	
Growth Ratios			
Sales Growth	The growth of sales over one year	$\frac{\lvert \text{Sales}_{current} - \text{Sales}_{previous} \rvert}{\text{Sales}_{previous}}$	Roodposhti et al. (2018)
Net Income Growth	The growth of net income over one year	$\frac{\lvert \text{Net Income}_{current} - \text{Net Income}_{pre} \rvert}{\text{Net Income}_{previous}}$	
EPS Growth	The growth of EPS over one year	$\frac{\lvert \text{EPS}_{current} - \text{EPS}_{previous} \rvert}{\text{EPS}_{previous}}$	
Profitability Ratios			
Net Income Margin	Remaining sales after paying for interest, taxes, and preferred dividends	$\frac{\text{Net Income}}{\text{Sales}}$	Gitman et al. (2015); Jermsittiparsert et al. (2019); Musallam (2018); Prazak & Stavarek (2017); Roodposhti et al. (2018)
Earnings Per Share	Amount earned per share of common stock	$\frac{\text{Total Earnings}}{\text{Outstanding Shares}}$	
Return on Assets	Management's effectiveness in generating income with assets	$\frac{\text{Net Income}}{\text{Total Assets}}$	
Return on Equity	The return earned on the shared investment of stockholders	$\frac{\text{Net Income}}{\text{Total Equity}}$	
Market Ratios			
Price to Earnings Ratio	Amount investors are willing to pay for each dollar of a company's earnings	$\frac{\text{Stock Price}}{\text{Earnings Per Share}}$	Gitman et al. (2015); Jermsittiparsert et al. (2019); Musallam (2018)
Market to Book Value Ratio	Assesses the firm's performance from the investor's perspective	$\frac{\text{Stock Price}}{\text{Book Value Per Share}}$	

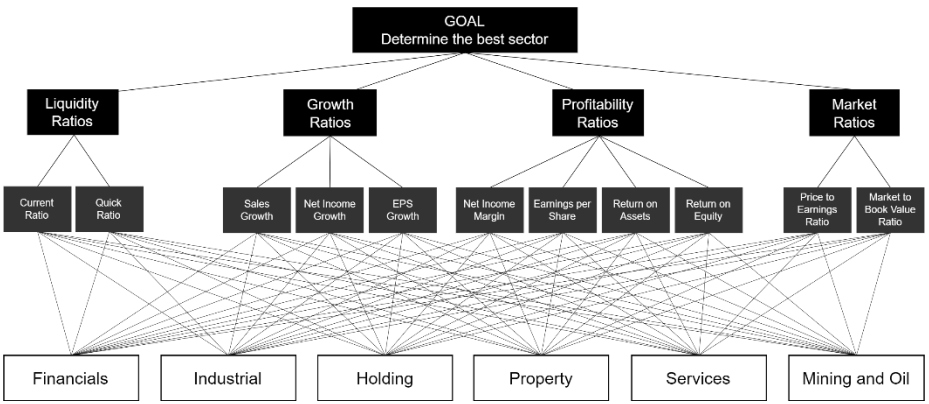
Data Source: PSE Edge, *Wall Street Journal Markets.

After the computations, the PSE-registered firms were grouped based on their corresponding sectors, and the average values of the financial ratios were summarized per given industry. The liquidity, growth, profitability, and market ratios served as the performance indicators for evaluating the sectors.

2.3.2 Analytic Hierarchy Processes (AHP)

AHP is a multi-criteria decision tool incorporating hierarchical and pairwise comparisons (Munier, 2018). Saaty (1977) introduced it as a decision-making tool. This approach begins with establishing a hierarchy with the goal at the highest level and the criteria at the following ones, while the pairwise comparisons between the factors come afterward (Roodposhti et al., 2018). The results rank the options by yielding values representing the relative dominance of one choice over another. The current study utilized the AHP method to get the weights of different financial performance criteria and rank the six industries based on their sectoral performance. The procedure started with the hierarchical structure shown in Figure 2.

Figure 2: Analytic Hierarchy Processes Framework



Based on the diagram, the PSE sectors were treated as alternatives, while the liquidity, growth, profitability, and market ratios served as criteria for evaluation. Each criterion included selected ratios as sub-criteria. In performing the pairwise comparisons, Expert Choice software was utilized. The weights of each criterion and sub-criterion were established through the respondents' pairwise comparisons. Once the relative importance of these performance indicators was derived, each industry alternative was compared based on the geometric mean of the financial criteria and ratios' ratings. The consistency ratios among the pairwise comparisons were maintained to be 10% or less. In line with the study of Lirn et al. (2015), having a consistency ratio of less than or equal to 10% indicates informed judgments. Finally, the synthesized results yielded two findings: the importance weights of the financial performance indicators and the determination of the best-performing sector and firms based on the highest weighted scores.

2.3.3 Fuzzy Time Series Markov Chain Model

The study attempted to forecast future share prices through FTS–MC as it determines the predicted share price in a more specific numerical value instead of simply selecting the extent of stock movement. FTS–MC's algorithm used historical data to construct TPMs to determine future closing prices. Unlike any other forecasting method, it extensively utilizes matrix and probability concepts; it puts a given closing price under a fuzzy state, and the forecasted stock price would be computed based on the probabilities of its occurrence during the past years (Kafi et al., 2019). The method integrates Fuzzy Time Series and Markov Chain concepts (Hui & Yusoff, 2021). Using the data from 29th December 2015 to 29th December 2020, FTS–MC was performed to forecast the 2021 closing prices of the selected companies. The current study followed the steps demonstrated by Kafi et al. (2019). First, the universal discourse U was determined based on the historical data's minimum (Dmin) and maximum (Dmax) time series. U is defined in Equation 1.

$$U = [D_{min} - D_1, D_{max} + D_2] \quad (1)$$

The U was divided into several n-equal intervals. Equation 2 shows the formula, wherein N denotes the number of historical data's time series.

$$n = 1 + 3.33 \log N \quad (2)$$

Afterward, the fuzzy set A_i was established using Equation 3, wherein μ_{ij} is defined further in Equation 4.

$$A_i = \frac{\mu_{ij}}{u_j} \quad (3)$$

$$\mu_{ij} = \begin{cases} 1 & i = j \\ 0.5 & j = i - 1 \text{ or } i = j - 1 \\ 0 & otherwise \end{cases} \quad (4)$$

The historical data was fuzzified based on the defined fuzzy set A_i, and a fuzzy logical relationship group was created. From here, the forecasted values for a given time t were calculated based on the rules defined in Equation 5. The variable m represents an interval's mean of the maximum and minimum values.

$$\mu_{ij} = \begin{cases} m_i & \text{if } A_i \to \emptyset \\ m_k p_{ik} & \text{if } A_i \to a_k,\ p_{ij} = 0 \text{ and } p_{ik} = 1 \text{ with } j \neq k \\ m_1 p_{j1} + \ldots + Y(t-1) p_j + \ldots + m_n p_{jn} & \text{otherwise} \end{cases} \quad (5)$$

Consequently, the initial forecasted values are added with the adjustment values of D_{t1} and D_{t2}. These are calculated based on Equations 6 and 7. The adjusted forecast value is calculated through Equation 8.

$$D_{t1} = \begin{cases} -\frac{1}{2} & \text{if } A_i \leftrightarrow A_i,\ A_i \leftrightarrow A_j,\ i < j \\ -\frac{1}{2} & \text{if } A_i \leftrightarrow A_i,\ A_i \leftrightarrow A_j,\ i > j \end{cases} \quad (6)$$

$$D_{t2} = \begin{cases} -\frac{1}{2} s & \text{if } A_i \leftrightarrow A_{i+s},\ i \leq s \leq n - i \\ -\frac{1}{2} v & \text{if } A_i \leftrightarrow A_{i-v},\ i \leq v \leq i \end{cases} \quad (7)$$

The adjusted forecast value is calculated through Equation 8.

$$F'(t) = F(t) \pm D_{t1} \pm D_{t2} \quad (8)$$

The forecasting accuracy of FTS–MC was based on the Mean Absolute Percentage Error (MAPE) concerning the predicted and actual closing prices of ten selected Property firms. The MAPE was computed using Equation 9.

$$\text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{Y(t) - Y'(t)}{Y(t)} \right| \times 100\% \quad (9)$$

The present study summarized the predicted and actual share prices for 2021. Ramadani and Devianto (2020) state that a MAPE of less than 10% denotes perfect forecasting accuracy. If the data's MAPE falls into the acceptable criteria, FTS–MC is perceived to be an accurate forecasting tool for studying the stock market behavior in the Philippines.

2.3.4 Portfolio Selection

A portfolio selection was performed to fulfill the final aim. Primarily, the investment pool was generated using the micro and macroeconomic analyses of the study. First, the industry of focus was determined using AHP; similarly, the top ten firms under the selected sector were chosen using the said multi-criteria decision analysis tool. These were considered in the investment pool as they were perceived to give excellent performance in terms of liquidity, growth, profitability, and marketability. Second, the FTS–MC's forecast selected the daily pool so that the portfolio included only the companies predicted to increase in share price on a given day. Moreover, the study utilized 2021 closing price data, and the selection was based on daily returns calculated using Equation 10.

$$Returns = \frac{Closing\ Price_{Current}}{Closing\ Price_{Previous}} - 1 \qquad (10)$$

The strategy employed in the model formulation was assumed to be equally likely. The probability assignment and selection model had equal weights of 1/n, where n denoted the number of companies with an anticipated price increase. Afterward, the generated portfolios were compared with the Philippine Stock Exchange data. The bases for comparison were the mean returns, standard deviation, number of positive and negative returns, cumulative returns, and the results of the Paired T-Test. The portfolio selection results served as the investment pool's performance evaluation.

3 Results

The present study investigated Philippine stock behavior using multi-criteria decision-making and Markov chain models. For the microeconomic analysis, the researchers determined the comparative importance of performance indicators based on respondents' pairwise comparisons. The raw data were then converted into values appropriate for AHP, where all ratings favoring a reference attribute were assigned a corresponding integer value from 1 to 9, and ratings selecting the opposite comparison attribute were assigned reciprocal importance values from 1/2 to 1/9. Afterward, the geometric means of these ratings were obtained and inputted in Expert Choice to determine a criterion's relative importance over another. The resulting weights, which depict the relative importance of the main criteria and their corresponding sub-criteria, are summarized in Table 2.

Table 2: AHP Importance Weights for Performance Indicators

Criteria	Weight	Sub-Criteria	Weight	Final Weight
Liquidity Ratios	0.230	Current Ratio	0.667	0.153
		Quick Ratio	0.333	0.077
Growth Ratios	0.340	Sales Growth	0.297	0.101
		Net Income Growth	0.540	0.184
		EPS Growth	0.163	0.055
Profitability Ratios	0.309	Net Income Margin	0.340	0.105
		Earnings per Share	0.287	0.089
		Return on Assets	0.237	0.073
		Return on Equity	0.136	0.042
Market Ratios	0.121	Price to Earnings Ratio	0.667	0.081
		Market to Book Value	0.333	0.040

After establishing the performance indicator's weights, the study chose an industry to be studied based on the top sector by performance. Upon gathering the raw financial reports of each firm and computing their ratios individually, the mean values of their performance indicators were summarized per sector. Outliers in the data were removed using Grubbs' Test. Given the weights and average financial performance, AHP was applied in the industry selection. Table 3 shows the AHP industry ranking and the ratings per sector.

Table 3: AHP Industry Ranking

Financial Ratios	Sector					
	Property	**Financials**	**Holding**	**Mining**	**Industrials**	**Services**
Current Ratio	0.247	0.116	0.266	0.124	0.124	0.124
Quick Ratio	0.183	0.119	0.273	0.142	0.142	0.142
Sales Growth	0.097	0.095	0.097	0.519	0.095	0.097
Net Income Growth	0.294	0.212	0.175	0.076	0.067	0.175
EPS Growth	0.245	0.123	0.107	0.406	0.056	0.062
Net Income Margin	0.341	0.167	0.167	0.141	0.100	0.084
Earnings Per Share	0.112	0.403	0.122	0.116	0.122	0.116
Return on Assets	0.243	0.080	0.127	0.236	0.277	0.038
Return on Equity	0.157	0.157	0.087	0.294	0.275	0.030
Price to Earnings	0.090	0.553	0.090	0.088	0.090	0.090
Market to Book Value	0.103	0.056	0.056	0.103	0.275	0.407
Overall Rating	0.224	0.180	0.172	0.171	0.130	0.123
Rank	1*	2	3	4	5	6

*Selected as the top industry by performance.

With Property topping the selection, the firms proceeding to the macroeconomic analysis came from this sector. In choosing the representative companies, the initial list of all

Property firms was initially filtered to retain those listed before 2000 and those with above Php 45 billion in total assets. A similar multi-criteria analysis method was applied to the list. Given identical criteria weights from the sector selection, the study compared the remaining firms based on their relative performance differences. Table 4 shows the AHP firm ranking, wherein only the top 10 Property companies were selected as part of the investment pool.

Table 4: AHP Firm Ranking

Company	Code	Overall Rating	Rank
Ayala Land, Inc.	ALI	0.227	1
Empire East Land Holdings, Inc.	ELI	0.100	2
Filinvest Land, Inc.	FLI	0.082	3
Global-Estate Resorts, Inc.	GERI	0.077	4
Philippine Infradev Holdings, Inc.	IRC	0.076	5
Megaworld Corporation	MEG	0.073	6
Robinsons Land Corporation	RLC	0.073	7
Sta. Lucia Land, Inc.	SLI	0.068	8
SM Prime Holdings, Inc.	SMPH	0.065	9
Vistamalls, Inc.	STR	0.059	10
Shang Properties, Inc.	SHNG	0.053	11
Century Properties Group, Inc.	CPG	0.049	12

After determining the top companies through microeconomic analysis, the study also investigated these firms' behavior in response to the external financial environment. Thus, the macroeconomic analysis performed FTS–MC to analyze the companies' stock movement and forecast future share prices based on their historical behavior. The researchers gathered the firms' daily closing prices from 29th December 2015 to 29th December 2020, excluding holidays. Based on the Markov model constructed using these data, the study predicted the daily closing prices from 4th January to 31st December 2021.

The initial procedure was to determine the universal discourses U of the Property companies based on their maximum and minimum spanned time series data. The U for the selected firms were as follows:

$U_{ALI} = [22.9, 53.50]$
$U_{ELI} = [0.20, 0.90]$
$U_{FLI} = [0.70, 2.20]$
$U_{GERI} = [0.60, 1.90]$
$U_{IRC} = [0.50, 2.90]$
$U_{MEG} = [1.80, 6.50]$
$U_{RLC} = [11.70, 32.10]$
$U_{SLI} = [0.70, 2.80]$
$U_{SMPH} = [18.80, 42.80]$
$U_{STR} = [3.10, 25.90]$

Next, as calculated using Equation 2, the universal discourses for all firms must be partitioned into 12 equal intervals. Consequently, each company's historical daily closing prices were fuzzified based on their corresponding intervals and fuzzy sets A_i showed in Equation 10. Each fuzzy state's frequencies and logical relationships were utilized to construct the fuzzy transition probability matrix essential in forecasting.

$$A_1 = \left\{\frac{1}{u_1} + \frac{0.5}{u_2}\right\}, A_2 = \left\{\frac{0.5}{u_1} + \frac{1}{u_2} + \frac{0.5}{u_3}\right\}, \ldots, A_{11} = \left\{\frac{0.5}{u_{10}} + \frac{1}{u_{11}} + \frac{0.5}{u_{12}}\right\}, A_{12} = \left\{\frac{0.5}{u_{11}} + \frac{1}{u_{12}}\right\} \quad (10)$$

Afterward, the 2021 closing prices for all companies were forecasted in Tables 42 to 51. Theoretically, if the current closing price falls under a specific fuzzy state, FTS–MC looks into its Markovian probabilities and applies rules using the conditions in Equation 5. Moreover, applicable adjustments based on Equations 6 and 7 were added. Tables 5 to 14 illustrate the forecasting.

Table 5: Illustrative Forecasted and Actual Closing Prices for ALI

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	41.1124	42.00
01/05/21	41.9664	41.00
⋮	⋮	⋮
12/31/21	35.9382	36.70

Table 6: Illustrative Forecasted and Actual Closing Prices for ELI

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	0.3107	0.32
01/05/21	0.3107	0.31
⋮	⋮	⋮
12/31/21	0.2617	0.26

Table 7: Illustrative Forecasted and Actual Closing Prices for FLI

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	1.1106	1.11
01/05/21	1.1031	1.10
⋮	⋮	⋮
12/31/21	1.0956	1.10

Table 8: Illustrative Forecasted and Actual Closing Prices for GERI

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	0.9268	0.93
01/05/21	0.9357	0.92
⋮	⋮	⋮
12/31/21	1.0121	1.01

Table 9: Illustrative Forecasted and Actual Closing Prices for IRC

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	1.3978	1.38
01/05/21	1.3716	1.38
⋮	⋮	⋮
12/31/21	1.0990	1.12

Table 10: Illustrative Forecasted and Actual Closing Prices for MEG

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	4.2361	4.18
01/05/21	4.0192	4.07
⋮	⋮	⋮
12/31/21	3.3003	3.15

Table 11: Illustrative Forecasted and Actual Closing Prices for RLC

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	21.0042	21.25
01/05/21	21.0465	21.20
⋮	⋮	⋮
12/31/21	19.4088	19.20

Table 12: Illustrative Forecasted and Actual Closing Prices for SLI

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	1.9668	2.00
01/05/21	1.9830	1.98
⋮	⋮	⋮
12/31/21	2.8319	2.88

Table 13: Illustrative Forecasted and Actual Closing Prices for SMPH

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	39.2631	39.25
01/05/21	39.0839	39.50
⋮	⋮	⋮
12/31/21	34.6765	33.90

Table 14: Illustrative Forecasted and Actual Closing Prices for STR

Day	Forecasted Closing Price	Actual Closing Price
01/04/21	4.2760	4.16
01/05/21	4.1977	4.06
⋮	⋮	⋮
12/31/21	3.7768	3.72

It was evident in the illustrative forecasts from the previous tables that the price prediction for all companies was perceived to be close to the actual stock prices spanning the same period. Although the values were near each other, the mean absolute percentage errors for all forecasts were calculated to verify the prediction accuracy further. The results of the computations are summarized in Table 15.

Table 15: MAPE of Forecasting among Property Firms

Company	MAPE	Remarks
ALI	1.2334%	perfect forecast
ELI	1.7062%	
FLI	1.0963%	
GERI	1.7999%	
IRC	1.6294%	
MEG	1.5313%	
RLC	1.4157%	
SLI	2.1539%	
SMPH	1.1414%	
STR	1.7030%	

As evident in Table 15, the MAPE results' highest error was observed in SLI, while the lowest was in FLI. Regardless of these numbers, all companies' forecasts are considered perfect because all MAPE values were less than 10% (Ramadani & Devianto, 2020). Also, based on Figure 3, the forecasted and actual prices in 2021 were close and nearly followed a similar trend. These results verified that FTS–MC is a reliable forecasting tool, and this technique could be accurately applied, especially in studying stock prices.

Figure 3: Fuzzy Time Series Markov Chain

Finally, this study presented a portfolio selection model featuring the study's generated investment pool. In line with the microeconomic analysis, the pool considered in this research consisted of the ten selected firms from the best-performing sector—Property. Foremost, based on the AHP multi-criteria decision methodology, the chosen companies were perceived to have competent financial performance in terms of liquidity, growth, profitability, and market criteria. Another significant factor was that these companies have been operating for over 20 years, passing the history criterion. Concerning size, the selected firms also have total assets greater than Php 45 billion, making them ideal representative Property firms. Once the pool was established, the purpose of the macroeconomic analysis was to forecast the stock prices' anticipated movement. Thus, the study would include only those companies with a predicted price increase on a given day. Afterward, the study compared the generated portfolios with the PSE market

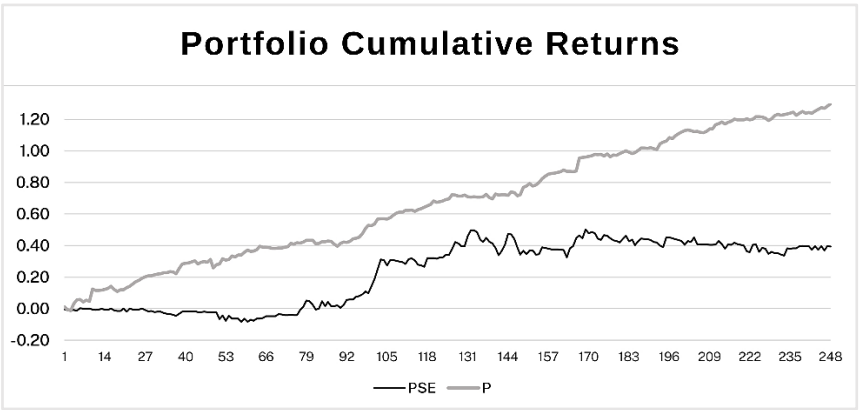
Table 16 compares the study's portfolio (P) to the market (PSE). Primarily, the results of the descriptive statistics entail that P yielded a higher mean price return of 0.0052. It also had a lower standard deviation of 0.0136 than the market, imposing that PSE has more risk in investment. Concerning the return count, P had higher positive and lesser negative returns. In addition, Figure 4 compares the cumulative returns of the portfolios. Consistent with the descriptive statistics, P also had higher ending cumulative returns, highest positive, and lowest negative cumulative returns, making it a favorable portfolio. Upon comparing the dataset using a more intensive Paired T-Test analysis, there was a significant difference between P2 and PSE, having a P-Value of 0.008. These results imply that investing in P would yield significantly higher returns than the market index.

Table 16: Portfolio Selection between P1 and PSE

	PSE	**P**
Count	248	248
Mean Returns	0.0016	0.0052
Standard Deviation	0.0218	0.0136
# of positive returns	93	161
# of zero returns	129	84
# of negative returns	26	3
Cumulative Returns	0.3926	1.2982
# of positive cumulative returns	177	246
# of negative cumulative returns	71	2
Paired T-Test T-Value		2.44
Paired T-Test P-Value		0.008*

*Significant at 0.05 significance level.

Figure 4: Portfolio Cumulative Returns



4 Discussion

The microeconomic analysis of the study evaluated the economic situation of each sector under the Philippine Stock Exchange. Mainly, from a micro perspective, stock prices are perceived to be influenced by internal company performance (Prazak & Stavarek, 2017). The present research has focused on the most outstanding financial performance sector, providing better opportunities to make stock investments worthwhile. In proceeding to the analysis, the industry selection through multi-criteria decision analysis ranked Property as the top sector, followed by Financials, Holding Firms, Mining and Oil, Services, and Industrials. This order was based on the most recent sectoral performance. Hence, present financial market conditions could elaborate on the ranking. Firstly, although Industrials and Services were generally known as profitable and efficient industries, the pandemic affected these sectors. Prawoto et al. (2020) emphasized that the industrial sector was impacted by the novel coronavirus when several manufacturing facilities were shut down across the globe. Khan et al. (2020) also stated that the SARS outbreak affected the stock returns of the Philippine service industry. Surprisingly, the Property sector topped the industry selection. Consistent with the study by Antenorcruz et al. (2020), Property has been the most efficient industry in recent years. Also, the real estate sector had relatively stable sales during the lockdown because people were restricted inside their homes, forcing them to secure their housing and property lease contracts (Shinozaki & Rao, 2021). In the long run, these increased revenues in the sector.

Because Property is perceived to have the best performance, the company selection would dwell under the said sector. The researcher implemented an identical multi-criteria decision analysis in the firm selection to determine the best representative firms. Furthermore, the study filtered the list of all Property companies in terms of history and

size. This process ensured that the pool of firms was top and preferable and had enough stock price data. Based on the selection, the ten representative companies were ALI, ELI, FLI, GERI, IRC, MEG, RLC, SLI, SMPH, and STR. As these Property firms were discerned to have an ideal economic situation, they proceeded to the macroeconomic analysis.

The microeconomic analysis determined the companies with outstanding performance. However, because the stock market behavior is also influenced by various macroeconomic variables (Adesokan, 2018), studies must simultaneously implement sophisticated optimization techniques to see how these firms react to the macroeconomic conditions of the financial market. In response to this need, the present study FTS–MC assesses stock behavior and forecasts future share prices. This method lets analysts know the predicted share price in a more specific numerical value instead of simply determining the extent of daily stock movement. FTS–MC's algorithm used historical data to construct TPMs to determine future closing prices. Unlike any other forecasting method, it extensively utilizes matrix and probability concepts; it puts a given closing price under a fuzzy state, and the forecasted stock price would be computed based on the probabilities of its occurrence during the past years (Kafi et al., 2019). In using this method, the current study discovered that FTS–MC is an accurate forecasting method for stock prices since all companies' mean absolute percentage errors denoted perfect forecasting. Thus, if investors utilized this tool in predicting stock movement, it would likely help them anticipate potential price increases based solely on how these shares behaved historically. By knowing a stock's forecasted behavior, venturers would logically create good investment decisions.

Lastly, this study conducted a portfolio selection as the final objective. Portfolio P considered the micro and macroeconomic analysis results; the investment pool comprised the ten selected firms based on AHP. It also used FTS–MC to determine those companies with an expected price increase on a given day; thus, these firms would only be the ones included in the daily investment pool. The researchers employed an equally likely selection strategy. Afterward, the researcher compared the generated portfolio with the Philippine Stock Exchange data. The difference between P and the PSE market index was significant, proving that investing in P would yield significantly higher returns. As evident in the study, applying sophisticated optimization techniques like Markov analysis simultaneously with multi-criteria decision analysis could generate a good investment pool instead of solely using microeconomic analysis. Thus, in addition to studying the company's internal situation, it is also crucial to consider external factors. Indeed, this research had successfully modeled a portfolio from a combination of middle and lower-tier firms that could become at par with the market consisting of blue-chip companies. Especially since buying blue-chip stocks is more expensive (Lubis, 2021), the study's findings provided potential investors with economical options. For those who wish to invest in companies with lower stock prices, the study proved that they could still possibly

acquire safe and reliable price returns as the PSE index through utilizing microeconomic and macroeconomic analysis of stock price behavior. Overall, the study's investment pool provided investors a profitable, sure, and worthy alternative option.

5 Conclusions

Several microeconomic and macroeconomic variables cause stochasticity in share price movement. Thus, simultaneously implementing multi-criteria decision analysis and Markov chain models could be advantageous for studying stock behavior. Using AHP, the microeconomic analysis of this study yielded Property as the top industry. Thus, ten representative Property firms proceeded to the macroeconomic analysis. The succeeding price forecasting using FTS–MC denoted a perfect forecast accuracy, aiding the researchers in predicting daily share price increases. Finally, the portfolio selection found that the study's generated portfolio significantly provided higher returns than the PSE market. In essence, the findings of this study are beneficial for both investors and enterprises.

Certain recommendations are still proposed for future studies. It is suggested that future studies compare two or more sectors in terms of performance and behavior. Also, potential researchers in this discipline could use other forecasting methods and compare these techniques. Lastly, an in-depth portfolio selection could be conducted by future researchers since this study used an equally weighted portfolio to the market performance.

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