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## Article

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# Comparison of the trading strategies and market impact costs of the National Pension Service's internal and external management

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## Abstract

As of May 2022, the National Pension Service of Korea is the world's third-largest pension fund, with assets worth KRW912tn (approximately \$US800bn). Of the KRW152tn (approximately \$US133bn) invested in domestic equities, 45% is outsourced to external asset managers. Given the absence of prior research on the National Pension Service's (NPS's) management method, this study analyzes its trading strategies and market impact according to the fund management method from 2005 to 2022. The results are as follows: First, the stock characteristics selected by internal management using passive strategies are different from those selected by external management, in which various strategies are combined. Second, the contrarian investment strategy, which acts as a market stabilizer, is a characteristic of the external management trading pattern, while internal management increases volatility and does not improve liquidity. Third, there has been a change in the internal management strategy since 2016, when the fund management headquarters was relocated. This study is practically significant and distinctive in that it confirms the differences between the NPS's two investment methods in terms of trading strategies and market impact.

**Keywords** National Pension Service, Internal management, External management, Investment strategy, Market impact

**Paper type** Research paper

## 1. Introduction

The National Pension Service's (NPS's) asset base in 2021 was worth KRW948.7tn (approximately \$US835bn), an increase of nearly 70% from KRW558.3tn (approximately \$US491bn) in 2016, and the proceeds (KRW236.8tn, approximately \$US208bn) over the past three years accounted for 45% of the total cumulative earnings (KRW530.8tn, approximately \$US467bn). As of the end of May 2022, domestic stocks accounted for 16.7% (KRW151.9tn, approximately \$US133bn) of the NPS' investment portfolio, and it plans to reduce the share to 14% by 2027. Regarding concerns over the impact of underweighting domestic stocks on the domestic stock market, the NPS said that considering the future increase in the NPS's management assets, the management amount for domestic stocks would be KRW30tn [KRW182tn (= KRW1,300tn × 14%) - KRW151.9tn].

**JEL Classification** — G11, G12, G23

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In addition to the debate over the NPS's portfolio, there is considerable debate over the management method for domestic stocks. The NPS entrusts 55% of domestic stock management funds to 30 external managers to improve investment returns and diversify risk, while it directly manages 45%. However, as the fund management headquarters relocated to Jeonju in 2016, 156 of the 326 fund managers were retired by 2021, making it difficult to recruit veteran experts. It is said that there is no significant change in the NPS's investment performance in domestic stocks; however, what about the investment performance by internal management? No analysis has compared the investment strategies or investment performances of the internal and external management. External (or outsourced) management entrusts stock trading to domestic and foreign asset management companies, while internal (or direct) management refers to internal trading by the NPS. According to the fourth fiscal estimate, a 1% point drop in the fund management yield would advance the fund depletion period by four years. This study compares the NPS's investment strategies and market impacts by management method and analyzes whether there is a difference between internal and external management.

The results of previous studies on the NPS's investment strategy and market impact are summarized as follows: First, the NPS uses a contrarian investment strategy to act as a market stabilizer when stock prices fall, and individual investors known as uninformed traders follow the NPS's trading (Kho *et al.*, 2008; Woo and Kim, 2018b, 2019). Second, there is no consensus on whether the NPS's trading expands volatility (Nam *et al.*, 2008; Ghil *et al.*, 2015; Kim and Woo, 2021a, b; Eom and Woo, 2021; Woo and Yang, 2019a, b). However, it is not known whether the NPS's internal and external management use the same contrarian investment strategy or cause the side effect of raising volatility.

Based on the NPS's trading data for the 17 years from August 2005 to June 2022, the results of analyzing the differences between internal and external management are as follows: First, internal management has few trading stocks and a low transaction turnover rate, whereas external management has many trading stocks and a high transaction turnover rate. Second, internal management prefers stocks with high liquidity and low volatility compared to external management. Third, external and internal management both use a contrarian investment strategy; however, internal management has been converted to a positive feedback investment strategy since 2016. Finally, external management increases liquidity and reduces volatility, whereas internal management does not improve liquidity but increases volatility.

These results show a difference in stock selection between internal management, which is known to use passive strategies, and external management, which combines various strategies. The result of previous research that the NPS acts as a market stabilizer by using a contrarian investment strategy is based on the external management trading strategy. However, it can be seen that internal management trading is unrelated to liquidity improvement and volatility mitigation.

This is the first study to analyze the NPS's investment strategy and market impact according to the management method for domestic stock. In addition, this study's contribution is significant because the research was based on public data, quotes and trades books without receiving data from the NPS.

The structure of this paper is as follows: [Section 2](#) summarizes previous studies, while [Section 3](#) describes the research data and methodologies. [Section 4](#) presents the research results, and [Section 5](#) concludes with the implications.

## 2. Literature review

Few studies focus on the NPS's investment strategy and market impact due to a lack of access to trading data. Kho *et al.* (2008) and Ghil *et al.* (2015) analyze research data provided by the NPS. Woo and Kim (2018b, 2019) estimate the NPS's trade details based on public information

and analyze them. However, no study has considered the difference between external and internal management depending on the NPS's fund management method.

Previous studies on the NPS's market impact are as follows: [Kho et al. \(2008\)](#) find that the NPS maintains continuous net buying transactions regardless of an increase or decrease in market returns during the sample period and uses a contrarian investment strategy. However, there is no evidence that the NPS's trading behavior affects individual stocks' volatility. [Nam et al. \(2008\)](#) emphasize that the NPS has played the role of a market stabilizer since 2000 and that the public pension's role as a market-neutral investor is a constraint that cannot be overlooked. [Woo and Kim \(2018b\)](#) show that the NPS adopts a contrarian investment strategy and contributes to market stabilization by reducing intraday volatility as its net purchases increase. [Woo and Kim \(2019\)](#) show that the NPS uses a contrarian investment strategy and plays a role as a market stabilizer in the KOSDAQ market. [Eom and Woo \(2021\)](#) analyze the NPS's market impact cost and show that the NPS adopts a trading strategy that reduces market impact through relatively efficient order placement compared to other market participants.

Previous studies on the NPS's investment strategy and performance are as follows: [Ghil et al. \(2015\)](#) show that the NPS's internal and external investments are 1.32% per annum and 4.44% per annum, respectively; however, the authors find no evidence that the NPS has predictive power for the market or individual stocks. [Kim and Woo \(2021b\)](#) analyze the NPS's trading patterns in the KOSDAQ 150 index futures market and find that it does not use the index futures for hedging or arbitrage trading purposes. They show that the index futures are used as complementary trading for the risk of tracking errors or nonsynchronous transactions when trading in the spot market is temporarily not smooth. [Woo and Yang \(2019a\)](#) analyze the short-term informational power of the NPS's transactions. The results show that the daily holding rate of return on the long-short strategy using the NPS's net purchase amount ratio is 1.24%, showing significant performance that turns insignificant after the third day. This result is interpreted as the result of temporary price pressure due to large-scale transactions, and the authors claim that the NPS does not have short-term private information. [Woo and Yang \(2019b\)](#) analyze the NPS's performance and find that its domestic stock portfolio shows an average monthly return of 0.57%, while most of the return is attributable to stock-selection ability and investment style.

[Kim and Woo \(2021a\)](#) analyze the NPS's trading in the KOSPI 200 index futures and find that the NPS uses the index futures to solve problems related to nonsynchronous trading in the spot market. They show that the NPS does not trade the KOSPI 200 Futures for hedging or arbitrage. [Woo and Kim \(2021\)](#) find that the NPS's trading in the KOSPI 200 Futures has predictability for index futures and spot index returns. They show that the NPS's futures trading reduces the volatility of the spot and index futures markets and positively impacts the spot market's liquidity.

### 3. Data and methodology

#### 3.1 Data

This study analyzes the trading details of the NPS's external and internal management in the domestic stock market from 2005 to 2022. A two-step analysis process is adopted without receiving data from the NPS. First, from 2010 to 2022, details under the name of the "NPS" were collected from the "Report on the status of large holdings of stocks" and "Report on the status of ownership of specific securities by executives and major shareholders." From the collected data, the stocks, trading date and trading volume and amount for the NPS's trades in the domestic stock market are organized, and the NPS account is estimated by matching the account with the same trading details and execution book for each stock in the Korea Exchange [1].

For example, the NPS sold 561 shares of Lotte Chilsung Stock at KRW 1,612,889 per share on October 4, 2016. On September 29, 2016, with a difference between the trading date and the

T-2 date in the report, the NPS's H Securities account sold 561 shares at KRW 1,612,889 per share. Therefore, the account is presumed to be an NPS account. Hanwha TechOne, whose 6,580 shares were purchased by the NPS at KRW 63,130 per share on September 29, 2016, did not have an account with a matching volume on September 27, 2016, the T-2 days. Accordingly, when adding the NPS's M Securities account, which purchased 3,860 shares (KRW 63,107), and its S Securities account, which purchased 2,720 shares (KRW 63,163), the trading details matched. Therefore, the two accounts are presumed to be NPS accounts. To find an NPS account that matches the quantity and price in the report, the marketplace's pension fund accounts are selected to find one with the same quantity and price and, if not, two accounts are selected and combined to find a matching account. Consequently, based on 13 years of data, 11,409 accounts presumed to be NPS accounts are found.

Second, the NPS account is classified by operating entity. The NPS's stock investment is divided into external and internal management. The former entrusts stock trading to domestic and foreign asset management companies, while the latter refers to the NPS's direct trading. The NPS's fund management headquarters was relocated to Jeonju on June 10, 2015, in accordance with the local government relocation policy of central administrative agencies and public institutions. When submitting a quotation to the Korea Exchange, the order medium is additionally submitted along with the order details. The order medium makes it possible to distinguish between an internal management account for buying and selling stocks in Jeonju and an external management account for buying and selling stocks in Seoul by using IP address data. Accounts with overlapping internal and external management are excluded from the sample for the accuracy of the study. A total of 75 accounts are used by internal management, while a total of 7,909 accounts are used by external management, which is relatively high. The number of accounts used by internal management is approximately 65 per year, while the number of accounts used by external management ranges from a minimum of 2,000 to a maximum of 4,000 accounts per year. In contrast to the NPS's internal management, its external management selects a management company through performance evaluation annually, and the management company is replaced for poor performance or a change in investment strategy.

This approach can study the NPS's transaction details without receiving them from the NPS, although it may not be the entire transaction history. The transaction details of external and internal management for 17 years from August 2005 to June 2022 were analyzed to investigate the investment strategy, market impact and difference between the management methods.

### 3.2 Methodology

To analyze the NPS's trading strategies for internal and external management, the daily net-investment-flow (NIF) index is calculated by applying [Kamesaka et al.'s \(2003\)](#) concept of weekly NIF. NIF is an index that measures investors' trading direction as a ratio of net buying amount to daily trading amount, which is also used in studies by [Oh et al. \(2008\)](#), [Prasetyo \(2013\)](#), [Ahmed \(2014\)](#), [Woo and Kim \(2018a, b\)](#), [Damayanti and Ulpah \(2018\)](#) and [Woo and Kim \(2021\)](#). The NPS's investment direction is measured by subtracting the amount of a specific stock sold by the NPS on a specific day from the amount it purchased on the day and standardizing the sum of the two values. The detailed formula is as follows:

$$NIF_{i,t} = \frac{BuyWon_{i,t} - SellWon_{i,t}}{BuyWon_{i,t} + SellWon_{i,t}} \quad (1)$$

$NIF_{i,t}$ : Net investment flow of a specific security (i) on a specific day (t)

$BuyWon_{i,t}$ : Buying amount of a specific security (i) on a specific day (t)

$SellWon_{i,t}$ : Selling amount of a specific security (i) on a specific day (t)

[Eom and Woo \(2022\)](#) analyze the NPS's investment strategies. Because the national pension funds are executed through the internal operating committee's decision-making

process, the funds may be executed temporarily or partially depending on market conditions or fund size. Approximately 43% of the transactions are completed within a day, while 16% are divided into transactions that take more than five days. Therefore, the NPS's investment strategy based on its operation method is analyzed using a bivariate vector autoregressive model for the transaction details aggregated by market [2]. The formula is as follows:

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \epsilon_{i,t} \quad (2)$$

$NIF_{i,t}$ : Net investment flow of a specific security (i) on a specific day (t)

$Return_{i,t}$ : Daily return of a specific security (i) on a specific day (t)

All the variables that represent the characteristics of the stocks traded by the NPS are set as control variables [3]. To control for the clustering phenomenon of the standard deviation by stock and period, the regression analysis is performed by incorporating the fixed effects of stocks and period according to the method proposed by Thompson (2011). The analysis is based on the NPS's positive feedback trading strategy or contrarian trading strategy using its trading behavior based on past period stock returns. According to Woo and Kim (2018b), the NPS adopts a contrarian trading strategy in the stock market and, as the NPS's net purchases increase, this contributes to stabilizing the market by reducing intraday volatility. Woo and Kim (2019) explain that the NPS uses a contrarian trading strategy in the KOSDAQ market and its purchases of specific stocks positively impact the next day's returns, increasing liquidity and reducing volatility. They also explain that the NPS's trading is followed by national and local government investors and individuals. There is no prior research on whether the NPS is an informed trader; however, Choe *et al.*'s (2005) concept of volume-weighted average price can be used to analyze investment performance by calculating the ratio (Diff) of the NPS's average purchase or selling price to the market's average transaction price.

To analyze the impact of the NPS's trading (NIF) on individual stock returns, this study conducts regression analysis with daily (CtoC) and intraday (OtoC) returns as dependent variables, and the results are presented in Table 10. To examine the impact of the NPS's trading on individual stocks' liquidity, the spread and volume turnover ratios are used as dependent variables in the regression analysis, and the results are presented in Panels A and B of Table 11. Furthermore, to analyze the impact of the NPS's trading on individual stocks' volatility, intraday volatility is used as the dependent variable and the results are presented in Panel C in Table 11. To analyze the impact of the NPS's trading on individual stocks' investment performance, the difference between the purchase (or sell) price and the market price is used as the dependent variable in the regression analysis. The individual variables are panel data calculated by stock (i) and time point (t). Equation (3) is a regression model to analyze the impact of the NPS's trading, reflecting the various control variables and effect on individual stocks [4].

$$\begin{aligned} Variable_{i,t} = & a_0 + \mu_i + \lambda_t + \beta_0 \times NIF_{i,t} + \beta_1 \times CAR_{i,t-5,t-1} + \beta_2 \times Price_{i,t} + \beta_3 \times TrdWon_{i,t} \\ & + \beta_4 \times MktCap_{i,t} + \beta_5 \times TurnOver_{i,t} + \beta_6 \times TradeSizw_{i,t} + \beta_7 \times Spread_{i,t} \\ & + \beta_8 \times Volatility_{i,t} + \beta_9 \times Amihud_{i,t} + \epsilon_{i,t} \end{aligned} \quad (3)$$

CtoC: Daily return calculated by the closing price of the day compared to the closing price of the previous day

OtoC: Intraday return calculated by the closing price of the day compared to the opening price of the day

NIF: Net investment flow of a specific security (i) on a specific day (t)

CAR (Cumulative Abnormal Return) : CAR for the period t-5 ~ t-1

Price: Natural logarithm of the closing price for the day  
 TrdWon: Natural logarithm of the trading amount for the day  
 MktCap: Natural logarithm of the market capitalization for the day  
 TurnOver: Turnover rate calculated by dividing the trading volume on the day by the number of listed shares  
 TradeSize: Trading amount per trade divided by the number of trades on the day  
 Spread: Difference between the best ask price and the best bid price divided by the average of the two values  
 Volatility: Intraday volatility divided by the difference between intraday high and intraday low by the average of the two values  
 Amihud: Amihud illiquidity indicator, which is the absolute value of daily returns divided by the trading volume  
 Diff: Ratio of the average transaction price in the market divided by the average purchase (or sell) price of the NPS

#### 4. Results

##### 4.1 The NPS's asset-management size

From 2005 to 2022, the NPS has utilized 75 internal investment accounts and 7,909 external investment accounts, as shown in Table 1. The characteristics of the accounts used by the NPS depending on the investment method are as follows: First, the number of accounts used for the NPS's internal investment has continuously increased from 39 in 2005 to approximately 60 since 2011. Second, the number of accounts used for the NPS's outsourced investment has steadily increased from 913 in 2005 to 4,759 in 2016 but has decreased since then to approximately 2,000. Third, the proportions of trading volume for the NPS's direct and outsourced investment are, on average, 20 and 80%, respectively. However, according to officials from the NPS Fund Management Division, the proportions of funds directly invested and outsourced for domestic stocks are 45 and 55%, respectively. This is interpreted as a result of the relatively higher turnover rate of outsourced investment than direct investment.

	Internal management (billion won)			External management (billion won)			Internal management (%)		
	Number of accounts	Sell amount	Buy amount	Number of accounts	Sell amount	Buy amount	Number of accounts	Sell amount	Buy amount
2005	39	7,509	5,763	913	64,902	62,334	4.10	10.37	8.46
2006	44	26,711	20,689	1,360	109,735	120,599	3.13	19.58	14.64
2007	38	38,746	53,821	1,384	194,759	210,575	2.67	16.59	20.36
2008	41	30,345	89,672	1,588	211,596	252,185	2.52	12.54	26.23
2009	47	81,784	42,058	1,908	254,968	224,556	2.40	24.29	15.77
2010	52	18,598	76,799	2,056	234,264	263,474	2.47	7.35	22.57
2011	62	53,002	102,653	2,794	290,965	354,221	2.17	15.41	22.47
2012	63	60,399	82,243	3,128	271,545	291,843	1.97	18.20	21.99
2013	63	56,446	93,771	3,247	241,540	288,268	1.90	18.94	24.54
2014	66	63,960	88,632	3,680	315,491	340,903	1.76	16.86	20.63
2015	65	89,715	153,316	4,501	424,418	463,218	1.42	17.45	24.87
2016	66	54,809	63,263	4,759	354,458	373,460	1.37	13.39	14.49
2017	64	36,598	57,100	4,356	387,634	410,258	1.45	8.63	12.22
2018	66	49,546	57,980	3,766	380,416	390,639	1.72	11.52	12.92
2019	62	38,157	89,427	2,830	261,609	316,070	2.14	12.73	22.05
2020	64	96,415	78,299	2,384	342,490	354,970	2.61	21.97	18.07
2021	63	229,091	109,643	1,862	443,357	379,647	3.27	34.07	22.41
2022	58	69,360	60,471	1,655	160,541	158,712	3.39	30.17	27.59

**Table 1.**  
Number of accounts  
and trading amount

**Source(s):** Table by authors

Investors may trade one particular stock per day or trade a portfolio comprising multiple stocks for risk diversification. According to an analysis of the number of the NPS's daily trades, as shown in Table 2, internal management traded an average of 70 stocks per day over 4,170 days for the entire market, while external management traded an average of 290 stocks per day over 4,183 days. When separated by market, internal management traded an average of 62 stocks per day in the KOSPI market and 3 stocks per day in the KOSDAQ market. Meanwhile, external management traded an average of 228 stocks per day in the KOSPI market and 69 stocks per day in the KOSDAQ market.

Through these results, the characteristics of the NPS's management method can be identified. First, the number of investment instruments in external management is relatively higher than that in internal management. Second, over the 4,170 days analyzed, internal management traded a maximum of 18 KOSDAQ stocks and the median is only 1 stock, indicating that they do not focus on a significant portion of the KOSDAQ market. It is known that the NPS uses a passive strategy that tracks the index. This study confirms that the estimated target universe based on the internal investment history is consistent with the internal management investment strategy, which is determined to follow a passive strategy that tracks the market representative index [5].

The Herfindahl-Hirschman Index (HHI) is a measure that evaluates the concentration of an industry or market by squaring the market share of individual companies or investors and adding them up. Typically, if the HHI is above 1,200, the market is interpreted as concentrated or oligopolistic, and if it is above 2,500, it is interpreted as highly concentrated or monopolistic. In this study, the HHI is used to analyze the degree of stock concentration in the NPS's portfolio.

Table 3 shows the results of calculating the HHI using the ratio of individual stock-trading volume to total trading volume by year for the NPS. First, the HHI for the entire market under internal management is 369, while the HHIs for the KOSPI and KOSDAQ markets are 368 and 4,387, respectively. Second, the HHI for the entire market under external management is 132, while the HHIs for the KOSPI and KOSDAQ markets are 159 and 213, respectively. Third, a statistically significant difference is found between the HHIs for internal and external management in not only the entire market ( $t = 14.08$ ) but also the KOSPI ( $t = 11.38$ ) and KOSDAQ ( $t = 14.71$ ) markets, all at the 1% significance level.

These results, in addition to the fact that the NPS's investment universe is small, as shown in Table 2, indicate a significant concentration of trading in specific stocks. In particular, internal management consistently shows a bias toward specific stocks in the KOSDAQ market throughout the sample period. It is interesting to note that there are no trades made in

	Total market		KOSPI		KOSDAQ	
	Internal	External	Internal	External	Internal	External
Trading day	4,170	4,183	4,183	4,183	1,356	4,168
Mean	70	290	62	228	3	69
Std. dev	52	102	32	80	3	51
Max	213	847	212	719	18	213
99%	183	696	160	548	12	183
95%	164	498	125	384	11	160
90%	148	403	103	305	10	145
Q3	115	330	79	253	3	114
Median	54	272	60	213	1	54
Q1	23	223	36	182	1	23
10%	13	192	25	155	1	12
5%	9	172	21	137	1	8
1%	4	129	15	102	1	4
Min	1	60	9	45	1	1

Source(s): Table by authors

Table 2.  
Average daily number  
of trading stocks

Year	Total market				KOSPI				KOSDAQ			
	Internal		External		Internal		External		Internal		External	
	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy
2005	411	978	216	231	426	978	251	271	2,843		233	170
2006	344	268	174	175	345	273	200	199	6,482	9,965	254	310
2007	205	243	120	128	207	246	135	144	3,545	4,858	343	319
2008	198	351	141	152	199	357	154	166	4,541	3,411	512	592
2009	223	192	111	105	226	201	125	120	2,418	3,665	200	189
2010	245	264	121	116	251	266	138	134	6,495	4,756	219	211
2011	186	247	124	120	189	249	138	135	4,849	3,445	271	222
2012	211	331	122	117	216	340	143	139	1,334	1,995	209	173
2013	168	203	116	126	174	205	143	153	2,638	2,637	161	138
2014	152	176	120	105	154	177	144	125	2,703	2,433	203	232
2015	126	239	95	102	128	242	119	129	1,875	3,394	181	177
2016	392	130	103	128	396	131	124	152	5,347	1,923	169	151
2017	845	211	144	110	846	214	176	133	10,000	9,400	177	155
2018	303	653	115	103	304	510	141	128	2,315	9,799	166	170
2019	154	354	135	143	154	355	176	188	10,000	4,570	145	123
2020	624	305	120	152	626	306	162	204	895	1,358	128	107
2021	1,112	227	138	75	1,112	227	182	103			122	123
2022	1,137	883	132	209	1,137	883	171	276			178	243

**Table 3.**  
Concentration of  
stocks (HHI)

**Source(s):** Table by authors

KOSDAQ stocks by internal management during the COVID-19 period. Furthermore, while there was no significant concentration in specific stocks for internal management, such concentration is observed during the COVID-19 period. Moreover, the HHIs for internal and external management show a statistically significant difference at the 1% level not only in the overall market but also in the KOSPI and KOSDAQ markets.

The results of comparing the characteristics of the stocks traded by the NPS through internal and external management are presented in Table 4. In terms of liquidity, the number of stock transactions, quantity of stock transactions and amount of stock transactions are compared, and the spread, Amihud illiquidity measures and trading-volume turnover are also utilized. In terms of stock size, stock price and market capitalization are used, while intraday volatility is used to measure volatility by dividing the difference between the intraday high and intraday low by the average of the two values. The rate-of-return indicators are the daily rate of return, return on the day of opening compared to the previous day's closing price (CTOO) and return on the day's closing price compared to the day's opening price (OTOC).

The characteristics of the stocks traded by the NPS according to the management method are as follows: First, in the overall market, the liquidity of the stocks traded by internal management is higher than that of those traded by external management. Second, the size of the stocks traded by internal management is larger than that of those traded by external management. Third, the volatility of the stocks traded by internal management is lower than that of those traded by external management. Fourth, the return indicators for the stocks traded by external management are superior to those of the stocks traded by internal management. Finally, when comparing the characteristics of the stocks traded by internal and external management in terms of liquidity, volatility, stock size and performance indicators in both the KOSPI market (Panel B) and the KOSDAQ market (Panel C), the results are consistent with those of Panel A.

In the KOSDAQ market, the average market capitalization of the stocks traded by internal management is approximately KRW2tn, which ranks 17th in terms of market capitalization

Panel A: Total market						
	Number of trade	Trading volume	Trading amount (million won)	Price (won)	Market cap. (billion won)	Daily return (%)
Internal	12,770	679,716	35,283	124,978	78,272	-0.0577
External	9,078	583,392	19,659	82,040	36,882	0.1352
t-value	82.44**	15.17**	105.15**	111.7**	114.18**	-31.00**
	CTOO (%)	OTOC (%)	Volatility (%)	Turnover (%)	Spread (%)	Amihud (%*million won)
Internal	-0.0102	-0.0443	3.5043	0.6339	0.2832	0.0395
External	0.0869	0.0529	3.9634	1.0833	0.4476	0.1600
t-value	-32.62**	-16.81**	-84.4**	-70.12**	-15.83**	-23.44**
Panel B: KOSPI						
	Number of trade	Trading volume	Trading amount (million won)	Price (won)	Market cap. (billion won)	Daily return (%)
Internal	12,828	682,147	35,437	125,596	79,124	-0.0550
External	9,218	608,068	21,601	93,688	44,943	0.0949
t-value	75.77**	10.59**	84.99**	74.16**	83.35**	-24.88**
	CTOO (%)	OTOC (%)	Volatility (%)	Turnover (%)	Spread (%)	Amihud (%*million won)
Internal	-0.0103	-0.0417	3.4935	0.6249	0.2785	0.0383
External	0.0628	0.0365	3.7141	0.8262	0.3946	0.1550
t-value	-24.72**	-13.98**	-42.15**	-36.43**	-12.01**	-47.47**
Panel C: KOSDAQ						
	Number of trade	Trading volume	Trading amount (million won)	Price (won)	Market cap. (billion won)	Daily return (%)
Internal	8,823	512,677	24,699	82,513	19,696	-0.2382
External	8,565	492,507	12,508	39,137	7,188	0.2838
t-value	0.91	0.72	17.52**	47.70**	54.66**	-8.89**
	CTOO (%)	OTOC (%)	Volatility (%)	Turnover (%)	Spread (%)	Amihud (%*million won)
Internal	-0.0087	-0.2240	4.2475	1.2525	0.6048	0.0515
External	0.1753	0.1134	4.8819	2.0300	0.6429	0.1750
t-value	-7.07**	-6.16**	-12.76**	-10.57**	-0.35	-24.33**

**Table 4.** Characteristics of the stocks traded by the NPS

in the KOSDAQ market, while the average market capitalization of stocks traded by external management is approximately KRW700bn, which ranks 84th in terms of market capitalization in the KOSDAQ market. These results show that, contrary to what is known for trading only blue-chip stocks with large market capitalization, the NPS also trades stocks with lower market capitalization levels and that such trading is led by external management. [Woo and Kim \(2019\)](#) argue that the NPS's trading can trigger herd behavior by the government, local governments and individual investors. The NPS's trading in small-cap

stocks may lead to reckless buying by individual investors, causing instability in the prices of those stocks.

4.2 The NPS's investment strategy

According to previous studies, the NPS uses a contrarian investment strategy whereby it increases purchases as stock prices fall and increases sales as stock prices rise. For example, Kho et al. (2008), who analyze the NPS's trading data from 2000 to 2004, and Woo and Kim (2018b, 2019), who analyze the NPS's trading records from August 2005 to July 2017, obtain these results.

Based on the analysis of NPS's trading records from 2005 to 2022, this study presents investment strategies according to the NPS's asset management strategy using a bivariate vector autoregressive model in Table 5. According to the results, first, both external and internal management use a contrarian trading strategy for the overall market. External management shows statistically significant negative values up to t-3, while internal management only shows significant negative values at t-1. Second, both external and internal management use a contrarian trading strategy for the KOSPI market, and the significance of the explanatory power for past returns is also at the same level. Third, for the KOSDAQ market, internal management shows a negative value that is statistically

Variable	Total market		KOSPI		KOSDAQ	
	Internal Coeff t-val	External Coeff t-val	Internal Coeff t-val	External Coeff t-val	Internal Coeff t-val	External Coeff t-val
Return(t-1)	-2.2325 -5.18***	-0.7647 -3.26***	-2.2561 -5.23***	-0.7680 -3.26***	5.8428 1.49	1.4289 0.24
Return(t-2)	0.5369 1.24	-0.4864 -2.06**	0.5462 1.26	-0.4859 -2.06**	-6.2457 -1.82*	0.3061 0.18
Return(t-3)	-0.2520 -0.58	-0.6375 -2.71***	-0.2423 -0.56	-0.6433 -2.73***	-4.2178 -1.84*	0.4280 0.22
Return(t-4)	-0.2891 -0.67	0.1587 0.68	-0.2380 -0.55	0.1563 0.67	-5.8384 -2.09**	-0.9614 -0.23
Return(t-5)	0.0752 0.18	0.0060 0.03	0.1157 0.27	0.0057 0.02	3.0805 0.16	0.6755 0.12
Return(t-6)	-0.4549 -1.07	0.2804 1.22	-0.4619 -1.09	0.2759 1.19	-4.7173 -0.90	0.8657 0.30
Return(t-7)	-0.0660 -0.15	-0.5316 -2.27**	-0.0549 -0.13	-0.5299 -2.25**	-4.2853 -2.07**	-0.5084 -0.13
Return(t-8)	-0.5869 -1.37	-0.1907 -0.82	-0.5818 -1.36	-0.1956 -0.84	5.7540 1.60	0.8695 0.14
Return(t-9)	-2.0185 -4.74***	-0.4317 -1.86*	-1.9886 -4.66***	-0.4412 -1.89*	2.4979 1.40	-0.1225 -0.03
Return(t-10)	-0.3149 -0.75	-0.5660 -2.48**	-0.3207 -0.76	-0.5703 -2.49**	4.8995 1.85*	0.3000 0.11
Adj R-Sq	0.1786	0.8340	0.1788	0.8338	0.8290	0.9760

Note(s):

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \varepsilon_{i,t}$$

$NIF_{i,t}$  is the daily net investment indicator of the NPS, and  $Return_{i,t}$  is the daily rate of return of a specific stock on a specific day. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

Source(s): Table by authors

Table 5.  
NPS's investment  
strategy I

significant from t-2 and shows a contrarian trading strategy, whereas external management does not show a statistically clear investment strategy.

Table 6 shows the results of analyzing the investment strategies for each group of stocks traded by the NPS according to their internal and external management methods. The stocks are sorted by day and individual stock and divided into three groups based on market capitalization; the investment strategies for each group are then analyzed. First, in the case of internal management, the contrarian trading strategy of increasing purchases as stock prices decline is statistically significant and negative only on day t-1 for the groups with the largest and middle market capitalizations. Second, the group with the smallest market capitalization shows a contrarian trading strategy, but it is not statistically significant. Third, in the case of external management, a contrarian trading strategy of decreasing purchases as stock prices rise is statistically significant and negative from day t-3 for the group with the largest market capitalization and from day t-2 for the group with the middle market capitalization. Fourth, in the case of the group with the smallest market capitalization, the pattern of the contrarian trading strategy does not show a statistically significant value.

Table 7 compares the investment strategies of the groups divided into three based on the daily trading amount for the NPS's internal and external management methods. Trading amount is an indicator that measures the liquidity of a stock. For internal management, the contrarian trading strategy shows statistically significant negative values only for the

Market cap Variable	Internal			External		
	Low Coeff t-val	Middle Coeff t-val	High Coeff t-val	Low Coeff t-val	Middle Coeff t-val	High Coeff t-val
Return(t-1)	-1.7890 -0.35	-4.7086 -3.81***	-1.9434 -4.21***	-1.3848 -1.07	-0.7545 -1.74*	-0.7820 -3.00***
Return(t-2)	-10.3756 -1.88*	2.2062 1.73*	0.3720 0.81	0.7516 0.54	-1.0354 -1.94*	-0.4180 -1.70*
Return(t-3)	-0.7037 -0.14	-0.0939 -0.07	-0.1893 -0.41	0.6586 0.53	0.1099 0.21	-0.7318 -2.81***
Return(t-4)	-6.6910 -1.29	0.5683 0.45	-0.3171 -0.69	-0.3205 -0.24	0.3828 0.72	0.1410 0.54
Return(t-5)	4.0507 0.81	0.8900 0.75	-0.0922 -0.20	-0.4679 -0.38	0.5488 1.09	-0.0476 -0.18
Return(t-6)	-5.3933 -1.18	-1.0166 -0.86	-0.2948 -0.65	-0.0860 -0.07	0.7774 1.55	0.1767 0.69
Return(t-7)	2.1951 0.41	2.1038 1.75*	-0.4222 -0.91	-0.1630 -0.12	-1.0417 -2.06**	-0.4626 -1.77*
Return(t-8)	-2.8595 -0.52	1.3665 1.17	-0.8773 -1.90*	-1.1724 -0.87	0.3294 0.67	-0.2412 -0.92
Return(t-9)	1.7114 0.36	-1.9292 -1.68*	-2.0687 -4.48***	-0.8468 -0.72	-0.5677 -1.18	-0.4167 -1.59
Return(t-10)	2.2951 0.45	2.0046 1.78*	-0.7824 -1.73*	-1.3032 -1.05	-1.3005 -2.75***	-0.4581 -1.78*
Adj R-Sq	0.4009	0.1826	0.1749	0.9656	0.8868	0.8253

**Note(s):**

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \varepsilon_{i,t}$$

$NIF_{i,t}$  is the daily net investment indicator of the NPS, and  $Return_{i,t}$  is the daily rate of return of a specific stock on a specific day. The stocks are divided into three groups based on market capitalization. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

**Table 6.**  
NPS's investment strategy II

Trading amount Variable	Internal			External		
	Low Coeff t-val	Middle Coeff t-val	High Coeff t-val	Low Coeff t-val	Middle Coeff t-val	High Coeff t-val
Return(t-1)	-0.1449 -0.04	-3.7154 -3.06***	-2.1214 -4.60***	-0.2617 -0.30	0.4139 0.70	-0.8324 -3.15***
Return(t-2)	0.7931 0.25	1.7734 1.49	0.3847 0.82	1.1665 1.44	-1.0760 -1.87*	0.3597 1.35
Return(t-3)	-3.4255 -1.08	1.4253 1.26	-0.4277 -0.91	0.2937 0.37	-1.0357 -1.88*	0.5867 2.19**
Return(t-4)	-1.2294 -0.37	1.0039 0.89	-0.4525 -0.97	-0.2931 -0.35	-0.1529 -0.28	0.2015 0.75
Return(t-5)	-1.0828 -0.34	1.3173 1.23	-0.1447 -0.31	-0.5812 -0.72	0.7199 1.38	-0.1419 -0.53
Return(t-6)	-2.6690 -0.81	-1.0910 -1.02	-0.1977 -0.43	0.9395 1.14	0.9485 1.83*	0.1063 0.40
Return(t-7)	8.0986 2.53**	1.1289 1.04	-0.5448 -1.16	-1.2073 -1.49	-0.7158 -1.36	-0.4952 -1.84
Return(t-8)	-0.4017 -0.13	1.1214 1.05	-0.9037 -1.93*	-0.4711 -0.62	0.1725 0.33	-0.2231 -0.83
Return(t-9)	-5.2070 -1.84*	-1.5256 -1.45	-2.0038 -4.27***	1.2187 1.72*	-0.0546 -0.11	-0.5588 -2.08**
Return(t-10)	5.0740 1.72*	-0.6356 -0.61	-0.4013 -0.87	-1.8621 -2.55**	-1.5942 -3.16***	-0.2895 -1.09
Adj R-Sq	0.2052	0.1888	0.1743	0.9558	0.8516	0.8248

**Note(s):**

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \varepsilon_{i,t}$$

$NIF_{i,t}$  is the daily net investment indicator of the NPS, and  $Return_{i,t}$  is the daily rate of return of a specific stock on a specific day. The stocks are divided into three groups based on market capitalization. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

**Table 7.**  
NPS's investment  
strategy III

highest and middle groups of liquidity on day t-1. For external management, the contrarian trading strategy shows statistically significant negative values only for the highest liquidity group on day t-1. In both internal and external management, there is no statistically significant contrarian trading strategy for the group with the lowest liquidity.

The results shown in Tables 6 and 7 indicate that different investment strategies are being used for stocks with high market capitalization or liquidity and those with low market capitalization or liquidity.

Table 8 shows the results of analyzing the trading strategy according to the NPS's internal and external management by time period [6]. First, based on data from August 2005 to July 2017, Woo and Kim (2018b, 2019) conclude that the NPS uses a contrarian trading strategy. Similarly, both internal and external management show a contrarian strategy for the period from 2005 to 2015.

Second, based on data from 2016 to 2019, external management still shows a contrarian strategy, while internal management shows a trend-following strategy. In terms of market capitalization, the median and upper groups of internal management show a positive-feedback trading strategy, while for external management, a positive-feedback trading strategy is only observed in the upper group. Furthermore, when based on trading amount, internal management shows a trend-following strategy in all groups, while for external management, the trend-following strategy is only observed in the group with the highest

Year	Internal				External			
	05~10	11~15	16~19	20~22	05~10	11~15	16~19	20~22
Variable	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff
	t-val	t-val	t-val	t-val	t-val	t-val	t-val	t-val
Return(t-1)	-0.1002 -2.12**	-3.0651 -2.84***	4.1960 5.09***	2.3707 3.01***	-1.4722 -2.60**	-1.8279 -1.88*	-0.1716 -1.83*	0.0539 0.30
Return(t-2)	-2.9841 -3.54***	-1.1887 -1.98**	0.1186 0.14	0.0481 0.06	-1.1322 -2.01**	-2.0973 -2.12**	-0.7113 -2.60**	-0.0334 -0.18
Return(t-3)	-1.7131 -2.01**	0.0942 0.09	-1.7614 -2.17**	-0.7611 -0.96	-1.4341 -2.51**	1.3954 1.40	-0.0359 -0.13	0.2196 1.22
Return(t-4)	0.3891 0.46	1.3442 1.24	-1.1277 -1.40	-0.8952 -1.12	-1.4205 -2.48**	-1.8445 -1.89*	0.3094 1.16	-0.0540 -0.30
Return(t-5)	1.6137 1.88*	1.5965 1.49	-0.2942 -0.37	-1.2830 -1.68*	0.1943 0.34	-0.9765 -1.01	0.3455 1.31	-0.2559 -1.47
Return(t-6)	0.3813 0.44	0.2691 0.25	-1.0845 -1.37	-0.9135 -1.19	1.5197 2.65***	-0.9773 -1.00	-0.2492 -0.95	-0.1184 -0.68
Return(t-7)	0.9240 1.05	0.1758 0.16	-0.7338 -0.93	0.2293 0.29	-0.7631 -1.30	-1.4823 -1.50	-0.0768 -0.29	-0.2612 -1.45
Return(t-8)	-0.6726 -0.78	-0.3429 -0.32	-0.4718 -0.60	-0.1028 -0.13	-0.7791 -1.37	0.0378 0.04	0.1083 0.42	-0.0040 -0.02
Return(t-9)	-1.6769 -1.94*	-1.0832 -1.00	-0.6967 -0.91	-3.6559 -4.59***	-1.0329 -1.80*	-0.6841 -0.70	-0.2020 -0.79	-0.1534 -0.84
Return(t-10)	-0.8582 -1.01	0.5707 0.53	0.0802 0.11	-0.2506 -0.32	-2.0713 -3.67***	0.0875 0.09	0.3168 1.27	-0.3026 -1.69*
Adj R-Sq	0.0885	0.1914	0.1837	0.2533	0.7326	0.5345	0.9410	0.9718

Note(s):

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \epsilon_{i,t}$$

$NIF_{i,t}$  is the daily net investment indicator of the NPS, and  $Return_{i,t}$  is the daily rate of return of a specific stock on a specific day. The stocks are divided into three groups based on market capitalization. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

Source(s): Table by authors

Table 8. NPS's investment strategy IV

liquidity. Third, in the cases of 2020 and 2021, when the stock market surged due to COVID-19, and in the case of 2022, when the stock market plummeted, internal management shows a trend-following strategy, while external management shows a trend-following strategy that is not statistically significant.

This shows different results from previous studies that the NPS plays a role in market stabilization by using a buy strategy during market downturns. In particular, since the Fund Management Headquarters relocated to Jeonju in 2016, it has used a buy strategy during a rapid rise of the stock market and a sell strategy during market downturns, which can be interpreted in various interesting ways.

Table 9 presents the results of analyzing the weekly data from Table 5. For NIF, the weekly net investment index is obtained by calculating the weekly buying and selling amounts, and the weekly rate of return is calculated. For convenience, only the results up to week t-3 are shown. The analysis shows that both internal and external management show statistically significant negative values only in week t-1 in the overall market. Similarly, for stocks in the KOSPI market, statistically significant negative values are observed only in week t-1. However, for stocks in the KOSDAQ market, internal management shows a statistically significant positive value, while external management shows a significant negative value. An analysis of the monthly buying and selling amounts (presented monthly) does not show significant results even in month t-1; thus, a separate table is not presented [7].

Variable	Total market		KOSPI		KOSDAQ	
	Internal	External	Internal	External	Internal	External
	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff
Return(t-1)	-0.4141 -3.47***	-0.2961 -2.43**	-0.4167 -3.64***	-0.2953 -2.18**	-0.1458 1.92*	0.2989 -1.87*
Return(t-2)	0.1370	0.0892	0.1384	0.0853	0.0207	0.1076
Return(t-3)	1.62	0.68	1.74*	0.78	0.26	1.32
Adj R-Sq	0.0776	0.0514	0.0738	0.0508	0.3911	0.0539
	1.10	0.74	0.52	0.05	2.13**	0.64
	0.3605	0.1466	0.3635	0.1424	0.2006	0.1661

**Note(s):**  

$$NIF_{i,t} = a_0 + \sum_{m=1}^{10} \beta_{1,t-m} \times Return_{i,t-m} + \sum_{m=1}^{10} \beta_{2,t-m} \times NIF_{i,t-m} + \varepsilon_{i,t}$$
*NIF*<sub>*i,t*</sub> is the daily net investment indicator of the NPS, and *Return*<sub>*i,t*</sub> is the daily rate of return of a specific stock on a specific day. The stocks are divided into three groups based on market capitalization. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively  
**Source(s):** Table by authors

**Table 9.**  
NPS's investment strategy V

4.3 The NPS's market impact

We analyze the impact of the NPS's trading strategy on the stock market according to the management method in terms of return, liquidity, volatility and efficiency. First, Table 10 shows the impact of the NPS's external and internal management on individual stock returns. Ghil et al. (2015) claim that the NPS's trades have no predictive power for the stock market or individual stock returns. However, according to Panel A of Table 10, which extends the analysis period to the latest after controlling for variables that affect individual stock returns, external management buying has a statistically significant positive impact on daily returns, while internal management buying has a statistically significant negative impact on daily returns.

Second, the impact of net transactions between external and internal management, which are calculated by deducting internal transactions from external transactions, shows a statistically significant positive value. Third, when the impact of external and internal transactions is included in the same regression model and the transactions compete, external transactions maintain their statistical explanatory power while showing a positive impact, whereas internal transactions show a negative impact. Fourth, when analyzed separately for the KOSPI and KOSDAQ markets, despite the NPS's relatively smaller trading volume in the KOSDAQ market, the impacts on daily returns of external and internal management are found to be the same. Net external purchases positively impact daily returns, while net internal transactions negatively impact daily returns.

The daily return is calculated as the ratio of the current day's closing price to the previous day's closing price, which reflects information that became available after the previous day's market close in the current day's opening price. Panel B of Table 10 analyzes the impact of the NPS's trading on the intraday returns calculated by the day's closing price compared to the day's opening price, excluding the information that became available after the previous day's market close. The NPS's net external and net internal purchases show statistically significant positive values for the intraday returns. Second, when external and internal transactions are included in the same model and their explanatory power is compared, the explanatory power of external transactions remains valid, whereas that of internal transactions is eliminated. Third, in the KOSPI market, both net external and net internal purchases show statistically significant positive values for intraday returns, and when they are included in the same

	Total market			KOSPI			KOSDAQ		
	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff
	t-val	t-val	t-val	t-val	t-val	t-val	t-val	t-val	t-val
Panel A: Daily return									
External	0.5764	0.5808	0.5781		0.5823	0.4820	0.5045		0.5045
	6.57***	7.17***	6.54***		7.11***	6.08***	6.40***		6.40***
Internal	-0.0974	-0.1137	-0.0936		-0.1099	-0.4236	-0.4443		-0.4443
	-5.00***	-7.72***	-4.37***		-7.07***	-5.92***	-6.26***		-6.26***
External-Internal									
		0.5322		0.5351		0.3278		0.3278	
		6.16***		6.28***		3.67***		3.67***	
Adj R-Sq	0.0331	0.0344	0.0337	0.0107	0.0349	0.1633	0.1770	0.1626	0.1548
Panel B: Intraday return									
External	<b>0.5376</b>	0.5373	0.5368		0.5364	0.6531	0.6609		0.6609
	8.17***	8.07***	7.82***		8.71***	8.89***	9.00***		9.00***
Internal	0.0236	0.0085	0.0250		0.0100	-0.1271	-0.1542		-0.1542
	4.46***	1.63	4.72***		1.91*	-1.89*	-2.33**		-2.33**
External-Internal									
		0.5678		0.5676		0.5945		0.5945	
		8.04***		8.80***		7.18***		7.18***	
Adj R-Sq	0.0391	0.0391	0.0391	0.0079	0.0391	0.0695	0.0713	0.0390	0.0586

**Note(s):**  $Variable_{i,t} = a_0 + \mu_i + \lambda_i + \beta_0 \times NIF_{i,t} + \beta_1 \times CAR_{i,t-5,t-1} + \beta_2 \times Price_{i,t} + \beta_3 \times TrdWon_{i,t} + \beta_4 \times MktCap_{i,t} + \beta_5 \times TurnOver_{i,t} + \beta_6 \times TradeSize_{i,t} + \beta_7 \times Spread_{i,t} + \beta_8 \times Volatility_{i,t} + \beta_9 \times Amihud_{i,t} + \varepsilon_{i,t}$

The effect of the trading of the NPS on the rate of return of individual stocks is regressed using the daily and intraday rate of return as the dependent variable. The daily rate of return is calculated as the closing price of the day compared to the closing price of the previous day, and the intraday rate of return is calculated as the closing price of the day compared to the market price of the day. Only the coefficient values of NIF are presented in the table, and the values for the control variables are not presented. \*, \*\*, and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

Table 10. NPS's market impact on return

model and their explanatory power is compared, both show statistically significant positive values. Fourth, in the KOSDAQ market's case, net external purchases show statistically significant positive values, while net internal purchases show statistically significant negative values. This result holds when both variables are included in the same model.

Spread is interpreted as an indicator of information asymmetry, which is calculated by dividing the difference between the best bid and best ask prices by the average of the two values. It can also be interpreted as a liquidity indicator, representing the additional cost that buyers or sellers must pay. In Panel A of [Table 11](#), it is found that as the NPS's external-management net buying increases, the spread decreases, contributing to improving liquidity. Meanwhile, an increase in internal management net buying results in an expansion of the spread and does not improve liquidity. These results hold even when both variables are included in the same model. Second, in the KOSPI market's case, it is found that external-management net buying improves individual stocks' liquidity while internal management net buying does not. Third, in the KOSDAQ market's case, external-management net buying continues to increase individual stocks' liquidity. Meanwhile, internal management net buying improves liquidity, although the effect is not statistically significant.

As an additional analysis of liquidity, the trading-volume turnover ratio, calculated by dividing the daily trading volume by the number of listed stocks on the day, is used as an indicator. According to Panel B in [Table 11](#), as the NPS's external-management net purchases increase, the trading volume turnover ratio also increases, which is statistically proven to contribute to liquidity. Meanwhile, an increase in internal management net purchases positively impacts the trading-volume turnover ratio, although the impact cannot be statistically proven. Second, when both external- and internal management net purchases are included in the same model, the impact of external management remains significant. Third, in the KOSPI market, external-management net purchases are found to increase liquidity by raising the trading-volume turnover ratio. Fourth, in the KOSDAQ market, it is found that neither external- nor internal management net purchases significantly impact individual stocks' trading-volume turnover ratio, indicating that they do not improve liquidity.

Panel C of [Table 11](#) presents the results of analyzing the effect of the NPS's trading on price volatility. The intraday volatility is calculated by dividing the difference between the daily high and low prices by the average of the two values. It is found that as the NPS's external-management net purchases increase, intraday volatility decreases significantly, while its internal management net purchases significantly increase intraday volatility. Second, when analyzing the effects of external and internal management, which have opposite effects on intraday volatility, in the same model, the impacts of the two variables are maintained in opposite directions. Third, in the KOSPI market's case, external management reduces intraday volatility while internal management increases it. Fourth, in the KOSDAQ market's case, external management increases intraday volatility, unlike in the KOSPI market, while internal management continuously increases intraday volatility.

[Choe et al. \(2005\)](#) evaluate whether a trader is an informed one by comparing foreign investors' average purchase or selling price to the market's average price. If the average purchase price is lower than the market's average price or the average selling price is higher than the market's average price, the trader can be interpreted as informed or as having good investment performance. This study aims to interpret the same indicator as representing investment performance rather than informed-trader status.

According to [Table 12](#), an increase in external management net purchases does not significantly improve investment performance as it raises the NPS's average buying price compared to the market average price. However, an increase in net sales significantly enhance investment performance at the 10% level by raising the NPS's average selling price compared to the market average price. Second, for internal management, neither an increase in net purchases nor an increase in net sales has a statistically significant impact on

	Total market		KOSPI		KOSDAQ	
	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val
Panel A: Spread						
External	-0.0001 -3.49***	-0.0001 -3.60***	-0.0000 -3.23***	-0.0001 -3.35***	-0.0058 -2.24**	-0.0057 -2.21**
Internal	0.0004 2.82***	0.0004 2.84***	0.0005 2.94***	0.0005 2.95***	-0.0013 -0.58	-0.0010 -0.44
External-Internal	-0.0001 -1.57	-0.0001 -1.57	0.0002 0.88	0.0002 0.88	-0.0077 -2.68***	-0.0077 -2.68***
Adj R-Sq	0.0448	0.0449	0.0441	0.0441	0.1605	0.1602
Panel B: Turnover						
External	0.0003 12.75***	0.0003 12.79***	0.0003 12.72***	0.0003 12.77***	-0.0001 -0.23	-0.0000 -0.16
Internal	0.0000 0.96	0.0000 1.45	0.0000 0.93	0.0000 0.93	-0.0003 -1.11	-0.0003 -1.09
External-Internal	0.0002 8.77***	0.0002 8.77***	0.0002 8.61***	0.0002 8.61***	-0.0006 -0.87	-0.0006 -0.87
Adj R-Sq	0.4525	0.4523	0.4499	0.4501	0.5872	0.5870
Panel C: Intraday volatility						
External	-0.0010 -2.88***	-0.0009 -2.41**	-0.0010 -2.87***	-0.0009 -2.41**	0.0018 3.26***	0.0016 3.04***
Internal	0.0014 7.38***	0.0013 6.50***	0.0014 3.33***	0.0013 3.45***	0.0017 3.46***	0.0016 3.26***
External-Internal	-0.0018 -6.36***	-0.0018 -6.36***	-0.0018 -3.35***	-0.0018 -3.35***	0.0021 3.58***	0.0021 3.58***
Adj R-Sq	0.3773	0.3795	0.3809	0.3807	0.3814	0.3840

**Note(s):**  $Variable_{i,t} = \alpha_0 + \mu_j + \lambda_i + \beta_0 \times NIF_{i,t} + \beta_1 \times CAR_{i,t-5,t-1} + \beta_2 \times Price_{i,t} + \beta_3 \times TrdWon_{i,t} + \beta_4 \times MktCap_{i,t} + \beta_5 \times TurnOver_{i,t} + \beta_6 \times TradeSiz_{i,t} + \beta_7 \times Spread_{i,t} + \beta_8 \times Volatility_{i,t} + \beta_9 \times Amihud_{i,t} + \varepsilon_{i,t}$

The effect of the trading of the NPS on the liquidity of individual stocks is regressed using the spread and turnover index as the dependent variable, and the effect on volatility is regressed using the intraday volatility indicator as the dependent variable. The spread is the difference between the best offer price and the best bid price divided by the average of the two values, the trading volume turnover is the value obtained by dividing the daily trading volume by the number of listed stocks, and the intraday volatility is the difference between the intraday high and intraday low price divided by the average of the two values. Only the coefficient values of NIF are presented in the table, and the values for the control variables are not presented. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

**Table 11.**  
NPS's market impact on liquidity and volatility

Variable	External buy Coeff t-val	External sell Coeff t-val	Internal buy Coeff t-val	Internal sell Coeff t-val	Buy Coeff t-val	Sell Coeff t-val
Panel A: Total Market						
External	174 3.39***	87 1.68*			90 11.74***	101 12.45***
Internal			46 1.01	32 0.60	31 5.01***	10 1.57
AdjR-Sq	0.0059	0.0118	0.0002	0.0068	0.0024	0.0096
Panel B: KOSPI						
External	173 3.36***	87 1.67*			89 11.46***	99 12.11***
Internal			49 1.06	34 0.64	30 4.97***	10 1.53
AdjR-Sq	0.0059	0.0118	0.0002	0.0068	0.0024	0.0095
Panel C: KOSDAQ						
External	976 0.83	823 0.50			289 3.92***	394 4.99***
Internal			-140 -3.47***	-970 -1.26	97 1.56	116 1.75*
AdjR-Sq	0.1074	0.2694	0.4681	0.0899	0.0162	0.0477

**Note(s):**

$Variable_{i,t} = a_0 + \mu_i + \lambda_t + \beta_0 \times NIF_{i,t} + \beta_1 \times CAR_{i,t-5,t-1} + \beta_2 \times Price_{i,t} + \beta_3 \times TrdWon_{i,t} + \beta_4 \times MktCap_{i,t} + \beta_5 \times TurnOver_{i,t} + \beta_6 \times TradeSizw_{i,t} + \beta_7 \times Spread_{i,t} + \beta_8 \times Volatility_{i,t} + \beta_9 \times Amihud_{i,t} + \epsilon_{i,t}$

To analyze the impact of the NPS's trading on the investment performance of individual stocks, a regression analysis is conducted using the indicator "Diff" as the dependent variable. In the case of net buying, the market's average price is divided by the NPS's average purchase price, and in the case of net selling, the NPS's average sale price is divided by the market's average price to calculate the "Diff" indicator. Here, the case of NIF >0 is classified as net buying, and the case of NIF <0 is classified as net selling. Only the coefficient values of NIF are presented in the table, and the values for the control variables are not presented. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

**Table 12.**  
NPS's market impact  
on investment  
performance

investment performance. Third, when external and internal management are analyzed in the same model, the external management selling strategy significantly improves investment performance, while the external and internal management buying strategies do not. Fourth, for the KOSPI market, the external management selling strategy enhances investment performance as the average selling price is higher than the market average price. Finally, for the KOSDAQ market, the internal management buying strategy significantly enhances investment performance while the external management selling strategy continues to show significant results.

4.4 Robustness test

Table 13 presents the results of robustness analysis to determine whether the market impact of the NPS's management method has changed during the COVID-19 period. According to Panel A, the impact of the NPS's external management on daily returns remains unchanged, while internal management negatively impacts daily returns before COVID-19 but has a statistically significant positive impact during the pandemic. In contrast, for Panel B, the impacts of the NPS's management methods on intraday returns show no difference between the periods before and during COVID-19 for both internal and external management.

Panel C, which reports on the spread, and Panel D, which reports on the turnover rate, analyze the effects of the NPS's management methods on individual stocks' liquidity. Before

Variable	Pre-COVID-19 period			COVID-19 period			Comparison of trading and MIC
	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val	Coeff t-val	
Panel A: Daily return							
External	0.5852 7.43***			0.5259 3.09***			<b>215</b>
Internal		-0.1262 -7.72***			0.0416 2.59**		
External-Internal			0.5239 5.50***			0.5721 2.32**	
Panel B: Intraday return							
External	0.5471 2.81***			0.4859 3.93***			
Internal		0.0132 2.31**			0.0771 5.35***		
External-Internal			0.5744 6.70***			0.5423 2.88***	
Panel C: Spread							
External	-0.0012 -5.46***			0.0007 2.86***			
Internal		0.0008 4.21***			0.0007 3.83***		
External-Internal			-0.0021 -8.19***			0.0001 0.79	
Panel D: Turnover							
External	0.0001 5.56***			-0.0011 -12.51***			
Internal		0.0001 0.93			-0.0000 -2.81***		
External-Internal			0.0001 6.06***			-0.0008 -7.97***	
Panel E: Intraday volatility							
External	-0.0008 -6.12***			0.0017 4.67***			
Internal		0.0009 4.14***			0.0036 3.56***		
External-Internal			-0.0012 -3.11***			0.0040 3.75***	

**Note(s):**

$$Variable_{i,t} = a_0 + \mu_i + \lambda_t + \beta_0 \times NIF_{i,t} + \sum_{i=1}^N \beta_1 \times Control\ Variable_{i,t} + \varepsilon_{i,t}$$

The periods before 2020 are classified as pre-COVID-19, and the period from 2020 to 2022 is classified as the COVID-19 period. Only the coefficient values of NIF are presented in the table, and the values for the control variables are not presented. \*, \*\* and \*\*\* indicate statistically significant values at the 10%, 5% and 1% levels, respectively

**Source(s):** Table by authors

**Table 13.** Pre-COVID-19 period vs. COVID-19 period

COVID-19, external management improves the liquidity of trades; however, during the pandemic, it is found to consume liquidity. Analyzing the turnover ratio, internal management has no impact on liquidity before COVID-19; however, during the pandemic, it is found to consume liquidity. Panel E analyzes the impact of the NPS's trading on market volatility. External management, which has previously reduced volatility and acts as a stabilizer, tends to increase volatility during the COVID-19 period.

## 5. Conclusion and implications

The NPS approved the “2022–2026 Mid-term Asset allocation Plan” at its 6th Fund Management Committee in 2021. The plan aims to reduce the domestic equity allocation in the NPS’s portfolio from 21.1% as of January 2021 to 16.3% by the end of 2022, with a target allocation of 14.5% by 2026.

There are conflicting views on the NPS’s reduction of the domestic equity allocation as it plays a role as a stabilizing force in the domestic equity market while also being responsible for the nation’s retirement funds. Some argue that the NPS should consider investment performance conservatively, while others believe that political considerations, such as the NPS’s role as a stabilizing force in the stock market, should also be considered. This study begins with the question of whether the NPS’s fund management method can reconcile these concerns.

This study confirms differences in the NPS’s trading strategies and market impacts depending on the investment method: internal management or external management. The main results are as follows: First, internal management has fewer trading stocks and lower turnover rates, while external management has many investment targets and higher turnover rates. Second, internal management prefers stocks with high liquidity and low volatility compared to external management. Third, both external and internal management use contrarian trading strategies; however, after 2016, internal management switches to positive-feedback trading strategies. Fourth, external management tends to improve liquidity and reduce volatility, while internal management cannot improve liquidity and increases volatility.

This study confirms differences in stock selection between internal management, known for using passive strategies, and external management, which combines various strategies. In previous studies, it has been shown that the role of market stabilizers who use a contrarian trading strategy is due to the external management trading strategy, while internal management engages in trading that is unrelated to liquidity enhancement and volatility mitigation. From a practical perspective, the NPS’s management entities are divided into the Fund Management Division’s internal management team and asset-management companies that receive funds from the NPS, and it is estimated that the management entities’ investment objectives differ. In the case of external management, the fact that annual underperformance can lead to exclusion from reselection and the recovery of consigned funds can act as a constraint.

The study finds that the NPS’s investment strategy and market impact in the domestic stock market vary depending on the management method. Therefore, it is important to consider the management method as a significant factor in the decision-making process when conducting research on the NPS or considering its role in the future.

## Notes

1. Among the details presented in the ownership status report, such as executives and major shareholders, there is no case where the same account is not matched through the execution book and transaction details, so it is judged that the sample in this study represents the NPS.
2. The optimal time lag by Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) show a slight difference within 10 orders, so a 10-time lag is applied in a conservative way.
3. Among the variables used in previous studies, variables that do not have the problem of multicollinearity are selected [Roll (1984), Glosten and Milgrom (1985), Amihud and Mendelson (1986), Easley and O’Hara (1987), Grossman and Miller (1988), Neal (1992), Brennan and Subrahmanyam (1996), Cao *et al.* (1997), Madhavan and Sofianos (1998), Datar *et al.* (1998), Corwin (2004), Chordia *et al.* (2000), Mayhew (2002), Panayides (2007), Choe and Woo (2010)]
4. All the control variables added in the process of explaining the effect of the NPS on multiple variables are expressed in one formula. However, if the spread is used as a dependent variable, it is excluded from the control variable and the same applies to other variables.

5. Based on the holdings, the position is set and compared to the KOSPI 200 Index for the KOSPI stock group and the KOSDAQ 150 Index for the KOSDAQ stock group. As a result, it is judged to be a passive strategy to follow the market representative index.
6. It is divided into four time periods: 2020–2022 due to COVID-19, 2016–2019 due to the relocation of the fund management headquarters to Jeonju and 2005–2010 to reflect the impact of the 2008 global financial crisis.
7. We thank the reviewers for their comments.

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