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SLEEP QUALITY AND TRADING BEHAVIOR OF INDIVIDUAL INVESTORS ON THE STOCK MARKET

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Abstract. There are various factors that influence the trading behavior of individual investors in the stock market. This study, based on data from 405 individual investors, is the first to investigate the relationship between sleep quality and investors' trading behavior in the stock market. Sleep quality is assessed through factors such as sleep time, duration, number of awakenings during the night, and napping habits. By applying various regression methods (Logit, PCA, PLSR, GMM), the results show that increased sleep duration causes passive investors to hold fewer stocks in their portfolios during bull market years and to increase their holdings when the market declines. Conversely, for active investors, an increase of sleep duration prompts them to hold a greater number of stocks in their portfolios during bull market periods, and decrease their holdings during bear markets. Moreover, good sleep quality is correlated with improved investment performance for passive investors. Research also indicates that afternoon naps and nighttime sleep affect investors' trading frequency. This study provides valuable insights into investors' trading behavior in the stock market. We encourage investors to enhance the quality of their sleep and incorporate regular midday naps to remain mentally alert, ultimately leading to increased investment returns.

Keywords: sleep quality, individual investors, investor behavior, trading frequency, return rate, investment.

JEL Classification: G00, G34, G35.

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1. Introduction

Research on sleep is common in health, education, defense, and work, but its link to investment activities is less explored. Investment, a vital mental activity, is closely tied to sleep and mental health. According to Nofsinger and Shank (2018), sleep is crucial for those in finance and investments, motivating our research.

Previous studies mainly focused on sleep's effect on the overall stock and commodity markets. Kamstra et al. (2000) found that daylight-saving time (DST) changes, which disrupt sleep, contribute to the weekend effect, causing daily losses of $31 billion on major exchanges. Other studies also link DST to stock price fluctuations (Gonzalez & Li, 2024; Kamstra et al., 2010). LoCasio (2009) showed that jetlag impacts capital flow, foreign investment, and

commodity markets. Garrett et al. (2005) found that shorter days, causing seasonal affective disorder, lead to higher risk aversion and affect stock returns.

Another research direction, which has not been extensively explored, concerns the influence of sleep on individual investment decisions. Guarana et al. (2022) found that venture capitalists are influenced by the time of day they make investment decisions in early-stage companies. Investors with early bedtimes make better investment decisions in the morning, while those with late bedtimes make better decisions in the evening. Nofsinger and Shank (2018) studied the impact of sleep on financial risk and found that poor sleep habits lead to significant cognitive deficits in financial decisions. People who sleep poorly and suffer from sleep disorders may struggle to achieve investment success and take more risks than optimal, with serious consequences. Furthermore, the relationship between poor sleep and bias may lead to poor selection of investment opportunities with lower returns. Additionally, a study by Killgore et al. (2006) using the Iowa Gambling Task showed that sleep deprivation increases financial risk.

To date, research on the direct impact of sleep on the financial/stock market is limited. Some studies explore the effects of sleep disruptions on information processing in financial markets (Bazley et al., 2024; Shavandi & Khedmati, 2022), while others investigate the relationship between sleep cycles and investment decision-making (Guarana, 2022; Ekinci & Ersan, 2022). Some studies primarily focus on sleep quality and investor risk-taking behavior (Guarana et al., 2022; Nofsinger & Shank, 2018; Killgore et al., 2006). Our paper contributes to the theoretical base by: (1) being the first to investigate the influence of sleep on individual investors' trading activities in the stock market; (2) addressing how the duration and quality of night sleep affect trading frequency, portfolio size, and holding time of stocks; and (3) examining the role of afternoon naps (a typical habit in Vietnam) on trading behavior.

Results show no significant relationship between bedtime and trading frequency. However, good sleep quality makes investors more inclined to trade. Sleep duration affects different types of investors differently: for passive investors, longer sleep leads to fewer stocks in bull markets and more in bear markets; for active investors, longer sleep results in more stocks in bull markets and fewer in bear markets. Good sleep quality is associated with better investment performance for passive investors, but not for active investors, whose performance is influenced more by investment experience, job, and holding duration. We also recommend that securities firms and investment banks consider improving customer sleep quality, such as providing nap spaces, gym coupons, or even on-site gyms (Yang et al., 2012; Mendelson et al., 2016).

There are five sections in this study. The first section provides a summary, background information, and an explanation of the topic selection. The paper reviews the theoretical basis and previous related studies in the second section. Section 3 presents data and research methodology. Section 4 presents the study findings, discussion and robustness check. Finally, section 5 includes implications, limitations of the study and conclusion.

2. Literature review

2.1. Literature review on sleep

Kushida (2013) states that all studied species need sleep, while Walker (2017) notes its various benefits for both brain and body. However, the World Health Organization (WHO) and the American Sleep Foundation (AASM) report that two-thirds of adults in developed countries do not get the recommended eight hours of sleep per night. This sleep deficiency leads to serious mental health issues like depression and anxiety, as well as negative effects on social

relationships and financial stability, prompting the WHO to declare insomnia an epidemic in industrialized nations.

Two factors influence our sleep patterns: the 24-hour biological clock in our brain, which regulates circadian rhythms of alertness and tiredness, and the accumulation of melatonin, which increases sleep pressure the longer we stay awake. Despite everyone having a circadian rhythm, three common sleep time zones exist: early sleepers (9:00 p.m. to 5:00 a.m., 40%), night owls (1–2 a.m. to 9–10 a.m., 30%), and intermediate sleepers (30%) (Walker, 2017).

How do we know if we're getting enough sleep? According to Walker (2017), there are two key questions to consider. First, after waking up in the morning, can you go back to sleep at 10–11 a.m.? If the answer is yes, it may indicate that you're not getting a full 8 hours of sleep or that the quality of your sleep is poor. Second, can you function effectively without relying on coffee before noon? If the answer is no, there's a high likelihood that you're experiencing chronic sleep deprivation.

How do we know we are asleep? According to Walker (2017), two key criteria help determine this. Firstly, there's the loss of external awareness. During sleep, we lose clear awareness of our surroundings, even though our senses remain active and transmit signals to the brain. However, the majority of these signals are not processed. Secondly, our awareness of time changes. We lose conscious awareness of time when we sleep, creating a time gap that makes us believe we were asleep when we recall.

Human sleep cycles between two main types: NREM (non-rapid eye movement) sleep, which governs sleep depth, and REM (rapid eye movement) sleep, associated with dreams (Dement & Kleitman, 1957). Kales and Rechtschaffen (1968) standardized these stages, which shift approximately every 90 minutes. NREM predominates in the first half of the night, while REM dominates in the latter half. Transitions between these stages often lead to awakenings, explaining why people frequently wake during sleep (Walker, 2017).

As individuals age, REM sleep remains stable while NREM deep sleep declines, starting in the late 20s to early 30s. By age 40, NREM sleep can decrease by 60–70%, and by age 70, this decline may reach 80–90%. This reduction in NREM sleep contributes to health issues such as increased depression risk, decreased physical activity, limited alertness, and lower cognitive function, often marked by forgetfulness (Foley et al., 1995). Walker (2017) notes that chronic sleep deprivation leads to similar physical and mental declines at any age.

Similar to nighttime sleep, afternoon naps have received considerable research attention. Pasha (2014) suggested implementing sleeping pods in Big 4 auditing firms to boost productivity and employee retention, with results indicating that midday naps enhance work performance and profitability. Yun and Beehr (2023) found that the effectiveness of naps varies based on cognitive domain and task difficulty. In their study, 18 college students alternating between napping and not napping performed better on tasks after naps. Ficca et al. (2010) noted that napping improves alertness and performance for about 2.5 hours after insomnia and nearly 4 hours after normal sleep, benefiting both procedural and declarative memory. Napping effects range from significant memory improvements to modest gains in reducing forgetting rates

How should we sleep? In many developed countries, individuals typically follow a monophasic sleep pattern, contrasting with our natural biphasic sleep instinct. The natural pattern involves about eight hours of nighttime sleep and a shorter nap of 30 to 60 minutes around noon. Adopting a monophasic pattern may shorten lifespan and increase the risk of disease-related mortality by over 60% (Walker, 2017). Based on the theoretical foundations of sleep, we propose two key concepts for further research: Good sleep: This includes sufficient, uninterrupted sleep during standard nighttime hours and the inclusion of naps;

Sleep deprivation: This occurs when individuals fail to get enough sleep at night, experience disrupted sleep quality, and/or neglect naps.

2.2. Sleep and investment activities

2.2.1. Sleep, emotions and behavior of investor

Good sleep helps the brain eliminate painful memories, reduce stress, and manage emotions better (Walker, 2017). Lack of sleep causes negative emotions, loss of control, and exhaustion: i) Kahneman (2011) states that sleeplessness weakens the body, impairing effortful thinking and leading to poor outcomes (Evans & Curtis-Holmes, 2005). ii) In the short term, stress increases; long-term sleep deprivation leads to psychological issues like divided attention, cognitive damage, reduced academic performance, and depression (Durmer & Dinges, 2005; Van der Helm et al., 2010). It also reduces concentration, delaying reaction times (Lim & Dinges, 2008). iii) Sleep deprivation causes emotional irrationality and uncontrollable reactions, preventing thorough consideration of situations (Walker, 2017). iv) Many people consistently get 1–2 hours less sleep than needed, not realizing the decline in performance. This chronic sleep deprivation causes mental harm and leads to poor performance, decreased alertness, and lower energy levels, becoming the accepted norm (Walker, 2017; Lim & Dinges, 2008).

The above can be explained through the activity of the prefrontal cortex. This is a region highly activated during decision-making, cognitive behavior, and emotions (Euston et al., 2012). When insomnia occurs, the neurological function of the prefrontal cortex will be weakened (Horne, 2012). The reason is that insomnia reduces the ability of the cerebral cortex to respond to incoming stimuli (Stins et al., 2007).

Damasio's (1994) Somatic Marker Hypothesis posits that emotions significantly influence decision-making, a process driven by the body's responses during biological regulation, including emotional signals. These signals can affect decision-making both consciously and unconsciously, with reason relying on emotional input for effective functioning. Bechara and Damasio (2005) highlight that sound decision-making hinges on accurate prior emotional processing. Investing, as a complex cognitive activity, requires careful data analysis before making decisions (Graham & Dodd, 1934). Thus, sleep plays a crucial role in emotional processing, impacting investment decisions and behaviors. A good night's sleep enhances emotional processing, leading to better decision-making and investment outcomes, while poor sleep results in poor decisions and outcomes.

Besides, Telzer et al. (2013) also found that sleep loss amplifies the imbalance in emotional and cognitive control, causing an increase in risk-taking. Meanwhile, risk is one of the important factors affecting investors' decisions and behavior. According to Hoffmann et al. (2015), investors with a high level of risk tolerance often increase their trading, have a high buying and selling ratio (short stock holding period), and hold a higher risk portfolio

From the above inference, we propose the first hypothesis *(H1): Investors with poor sleep will exhibit increased high-risk investment behaviors, including: i) increased trading, ii) a smaller number of stocks held in the portfolio (a portfolio with fewer stocks is generally considered riskier (Markowitz, 1952)), and iii) a shorter holding period.*

2.2.2. Sleep, cognition, and investment efficiency

Guarana et al. (2022) suggest that sleep will affect a variety of cognitive tasks of investors. Good sleep will have a positive effect on cognition for the following reasons:

First, a good sleep enhances knowledge absorption, consolidates information for long-term retention, and can even restore lost memories. A restful night before learning prepares the brain to create new memories. Walker (2017) notes that those who stay awake all day struggle to absorb knowledge, despite stable concentration levels. In contrast, napping improves study performance and memory recall by 20%. Sleep after learning further consolidates memories and reduces forgetting, with recall rates being 20% to 40% higher during sleep compared to wakefulness (Jenkins & Dallenbach, 1924). This is supported by research from Ngo et al. (2013), and Stickgold (2005). Additionally, sleep can help restore memories lost during the learning process (Plihal & Born, 1997).

Second, good sleep helps filter and organize memory, thereby increasing cognitive ability. This is achieved through NREM deep sleep, which plays a role in cleaning unnecessary neural connections while retaining necessary ones, with the aim of optimizing the brain's memory. In this way, sleep helps us filter and rearrange information, ensuring that the brain's memory remains clean, neat, and optimal, thus aiding in improved memory recall, knowledge, and skills (Walker, 2017).

Third, sleep improves human skills. Practice by itself does not create perfect skills, but rather practice, followed by a full night's sleep, leads to perfect skills (Walker, 2017).

Fourth, sleep helps the brain increase creativity. During sleep, REM sleep plays a crucial role in consolidating and strengthening neural connections to generate optimal "products" for memory, intelligent decision-making, and building relationships. The human social system is regulated by REM sleep. Compared to other evolved animals, humans spend an average of 9% more time in REM sleep, which is one of the reasons why humans are more intelligent and creative than other animal species. In REM sleep, discrete pieces of information in the brain are interconnected to form new combinations and foster creative insights. Thanks to this process, people can wake up the next morning with fresh solutions to challenging problems or unique ideas (Walker, 2017).

Guarana et al. (2022) argue that these cognitive tasks will interact with each other, affecting the amount of information that investors seek, which in turn, affects investment decisions. Nofsinger and Shank (2019) show that poor sleep habits lead to serious cognitive deficits in financial decisions. People who sleep poorly and suffer from sleep disorders can skew their ability to achieve investment success and may take on more risk than is optimal, which can have serious consequences.

From these inferences, we propose the second hypothesis *(H2): Investors who lack sleep will likely experience poorer investment performance compared to investors who get enough sleep*.

3. Data and methodology

We gather data on trading frequency, returns, stock holding duration, and the number of stocks in portfolios from securities accounts. Using the investors' contact emails, we distribute a survey questionnaire tailored to each individual. To minimize errors in their responses, we ask investors to track their sleep quality for at least one month before completing the survey. The daily sleep diaries were sent out in November 2021 and November 2022. The surveys were sent on January 1, 2022, and January 1, 2023. The survey responses were collected in early January 2022 and January 2023. All measurements in this study are average values. For instance, this includes the average number of nightly awakenings, the average duration stocks

are held in portfolios, the average trading frequency per stock, and the average number of stocks in the portfolio per year (calculated using monthly time-weighting).

3.1. Survey participants

This study employs a distinctive dataset. More precisely, the authors gathered the data by distributing questionnaires (Appendix) to individual investors actively participating in the Vietnamese stock market. A total of 520 questionnaires were dispatched, resulting in 405 responses received. The surveyed investors were recruited from economics and finance courses at various universities, ensuring that participants possessed a fundamental understanding of trading behavior and stock market returns. The surveyed investors were selected based on their graduation from economics and finance majors at various universities, ensuring they had a fundamental understanding of trading behavior and stock market returns.

Table 1. Demographic statistics from questionnaire

Panel A. Gender, age, marital status				
Male	Female	Total		
183	222	405		
Under 20 years old	From 20–30 years old	From 31–40 years old	From 41–50 years old	Over 50 years old
2	185	121	86	11
In relationship	Single	Married	Divorce	Others
105	173	112	15	0
Panel B. Education, job, investment experience				
High school	Undergraduate	Graduate	Postgraduate	
0	302	89	14	
Unemployment	Freelance work	The job is not related to securities finance	The job is related securities finance	
37	42	138	188	
<=1 year of investment experience	2 years of investment experience	3 years of investment experience	3–10 years of investment experience	>10 years of investment experience
82	94	103	81	45

Table 1 shows the sample statistics: 183 males (45.1%) and 222 females (54.8%). Among the 410 investors surveyed, 188 (46.4%) work in securities finance, while 217 (53.6%) do not, including 37 unemployed and 42 freelancers. The questionnaire was based on the Pittsburgh Sleep Quality Index (Buysse et al., 1989) and Liivamägi (2016) to study investors' sleep habits and stock trading behavior. Most respondents are young, aged 20 to 60, with an average age of 30, reflecting the youth of Vietnam's stock market, established in 2000.

Our sample has limitations, as focusing only on investors with financial economics degrees may not represent those without such training. However, it has advantages: first, using a sample with similar financial backgrounds reduces variability, improving control in experiments. Second, it better represents financial professionals, who are more likely to work as advisors,

traders, or managers. Many finance studies also use similar samples for these reasons (Negrea & Toma, 2017; Nofsinger et al., 2018; Saivasan & Lokhande, 2022).

3.2. Model

To investigate the impact of sleep on investors' trading behavior on the Vietnamese stock market, the authors analyzed using logit and OLS regression models. The main variables representing sleep quality include sleep onset time, duration of sleep during the night, number of times waking up during the night, and midday nap. Based on studies by Feng and Seasholes (2005) and Nicolosi et al. (2009), we measured investors' trading behavior using variables such as stock trading frequency, stock holding period, average number of stocks in the portfolio, and investor's return rate.

To analyze differences in trading behavior among various groups of investors, we divided them into three main groups based on their trading frequency in 2021 and 2022. Specifically, we ranked the trading frequency from low to high and then divided the investors into three equal parts according to tertile. The first group consists of investors with the lowest trading frequency, which we refer to as "passive trading investors," while the group with the highest trading frequency is referred to as active investors.

For the control variables in our empirical model, this study incorporates investors' education level, occupation, and years of investment experience, drawing upon references such as Liivamägi (2016), Quang et al. (2023), and Kourtidis et al. (2011). In the analysis of the influence of sleep characteristics on investors' trading activities, we employ probabilistic models. Given that our trading frequency data exhibits a considerable standard deviation, we opt to categorize investors into different groups based on tertiles before conducting regression analysis, thus mitigating the impact of outliers. Logit regression models have been previously utilized for similar data analysis, as demonstrated by Liivamägi (2016) and Gelman and Hill (2007).

To further assess the model's robustness, we employ an OLS regression model to examine the impact of sleep characteristics and other variables on groups of investors with varying trading frequencies during different market conditions, including bear and bull markets. The proposed model is as follows:

$$Trading\ \ Ativities = S_{-Time} + S_{\_Duration} + S_{\_Wake} + S_{\_Mduration} + Edu + Exper + Job. \quad (1)$$

In which, Trading Activities refer to variables such as trading frequency (Trading), number of stocks in the portfolio (HN), average stock holding duration (HP), and investor's return (Return). For details of the variables, see Table 2.

Table 2. Variable description

S_Time	Measures when investors sleep early or late. Due to the day/night change characteristic, times such as 12AM, 1AM, 2AM... will be taken as values of 12, 13, 14...	Survey by Questionnaire
S_Duration	Measures the investor's average total amount of sleep at night	Survey by Questionnaire
S_Wake	Number of times an investor wakes up at night	Survey by Questionnaire
S_Mduration	This is a dummy variable that takes the value of 1 if the investor takes a nap, and 0 otherwise	Survey by Questionnaire

End of Table 2

Exper	Investment experience is measured by the number of years spent participating in the market	Survey by Questionnaire
Edu	Education is measured by the total number of years of schooling. High school has a 12-year schooling period, university has a 16-year study period, a master's degree takes 18 years, and CFA and ACCA require an additional 3 years	Survey by Questionnaire
Trading	Average number of transactions per investor per year	Collected from account
HN	Average number of stocks held in the portfolio per year	Collected from account
Return	The average rate of return on investment per year	Collected from account
HP	The average duration for which stocks are held in the portfolio	Collected from account
Job	This is a dummy variable that takes the value of 1 if the investor works in the field of securities finance, and the value of 0 for all other cases	Survey by Questionnaire

4. Empirical results

4.1. Summary statistics

Table 3 shows the sleep patterns and investment behaviors of investors. On average, investors go to bed at 10:66 PM and sleep for 6.841 hours. The earliest bedtime is 8 PM, the latest is 4 AM, and investors wake up 0.62 times per night. They have an average of 4.16 years of investment experience, with the most experienced having 23 years. Most investors have 16 years of education, indicating university completion. In 2021, investors traded an average of 41.31 times, holding 4,009 shares, with a 33% return. In 2022, during market decline, trading dropped to 25.68 times, with 3,796 shares and a –20.6% return.

Table 3. Summary statistics

Variables	Mean	Std	Min	Max
S_Time	10.66	1.318	8.000	16.00
S_Duration	6.841	0.890	4.000	9.000
S_Wake	0.625	0.715	0.000	3.500
Exper	4.161	4.834	0.000	23.00
Edu	16.43	0.817	16.00	18.00
$Trading^{2021}$	41.31	49.98	0.000	252.0
$Trading^{2022}$	25.68	26.75	0.000	156.0
HN^{2021}	4.009	2.489	0.000	23.00
HN^{2022}	3.796	2.390	0.000	12.00
$Return^{2021}$	0.330	0.628	-0.700	4.300
$Return^{2022}$	-0.206	0.227	-1.000	1.200
HP	4.728	10.07	0.000	65.00

Note: 2021 represents the year when VNindex increases, and 2022 represents the year when VNindex decreases. All variables are described in Table 2.

4.2. Sleep and trading frequency of investors on the stock market

Table 4 presents sleep quality and stock trading frequency statistics. In 2021, early sleepers averaged 31.22 transactions per year, with a standard deviation of 36.01. The bottom 10% traded less than 11.6 times, while the top 10% traded fewer than 48.32 times. In 2022, during the market downturn, their average trades dropped to 22.56. Interestingly, 10% of early sleepers traded more than 13.12 times, an increase from 2021. Late sleepers had much higher averages – 51.65 trades in 2021 and 34.46 in 2022 – compared to both early sleepers and those with regular sleep schedules, suggesting late sleepers trade more frequently regardless of market trends.

In 2021, investors with little sleep at night (S_Duration_L) averaged 28.04 tradings per year, with a standard deviation of 28.66. The result also shows that 10% of people with little sleep traded less than 14.83 times per year. Interestingly, in the year when the stock market experienced a decline (2022), this group of investors increased their average number of transactions to 20.82 times per year. For the group of investors who sleep a lot at night (S_Duration_H), the average number of tradings reached 56.61 times in 2021, and reached 31.71 times in 2022. These results clearly indicate that investors who sleep more tend to trade more than those who sleep less

The frequency of waking up during the night is considered an important variable for assessing sleep quality. Investors who wake up fewer times during the night (S_Duration_L) tend to trade more than those who wake up many times (S_Duration_H). In particular, the mean value of the S_Wake_L variable is 49.43 for 2021 and 49.13 for 2022, both of which are higher than the mean values of the S_Wake_H variable (35.46 and 19.33). The results in Table 4 also indicate that investors who take midday naps (with a mean of S_Mduration_1 = 35.26) have a higher annual trading frequency compared to investors who do not take midday naps (with a mean of S_Mduration_0 = 33.34). All these statistics provide general evidence that, regardless of their sleep characteristics, investors tend to trade more when the market is rising than when it is falling.

Table 4. Statistics on stock trading frequency based on sleep variables

Variables	Trading frequency							
	Year 2021				Year 2022			
	Mean	Std	10th Pctl	90th Pctl	Mean	Std	10th Pctl	90th Pctl
S_Time_L	31.22	36.01	11.60	48.32	22.56	27.29	13.12	47.39
S_Time_M	34.73	37.24	13.55	51.45	27.78	19.50	13.67	48.77
S_Time_H	51.65	47.67	15.72	52.19	34.46	37.18	12.99	49.45
S_Duration_L	28.04	28.66	14.83	53.21	20.82	28.10	13.17	53.04
S_Duration_M	36.63	39.30	13.27	51.89	30.10	18.23	13.08	50.25
S_Duration_H	56.61	48.60	11.81	50.30	31.71	37.16	11.78	51.53
S_Wake_L	49.43	47.93	16.22	53.94	49.13	26.12	15.82	52.67
S_Wake_M	39.16	28.35	14.45	52.66	37.35	27.65	14.91	49.63
S_Wake_H	35.46	37.98	12.32	48.72	19.33	17.14	11.76	46.74
S_Mduration_0	33.34	48.03	12.20	49.30	31.60	28.19	12.02	49.16
S_Mduration_1	35.26	28.71	13.91	52.68	34.28	28.20	11.91	50.26

Note: S_Time represents the sleep onset time. S_Duration refers to the total time spent sleeping at night. S_Wake is the number of times wake up during the night; L, M, H are formed based on tertile. L is the group with the smallest value, M is the middle group, H is the group with the highest value; S_Mduration_0 refers to investors who do not take midday nap. S_Mduration_1 refers to investors who take midday nap; 2021 represents the year when VNindex increases, and 2022 represents the year when VNindex decreases.

Table 5. Examine the impact of various variables on stock trading frequency

Variable	Year 2021		Year 2022		Two years (2021–2022)	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
S_Time	12.43	1.346	11.95	1.309	14.47	1.172
S_Duration	14.36**	2.483	15.11	0.829	16.23**	2.401
S_Wake	–21.29**	–2.137	–23.45**	–2.861	–21.62***	–3.011
S_Mduration	31.62***	3.778	26.83***	3.101	28.43***	3.552
Exper	–16.94*	–1.850	–15.10**	–2.288	–15.44*	–1.476
Edu	8.382	1.504	8.095	1.003	6.022	1.293
HN	7.341	3.493	9.377	3.883	9.504	3.482
Return	–24.67**	–2.497	–21.12**	–2.136	–23.06**	–2.401
HP	–17.95***	–3.366	–16.77***	–3.495	–17.46***	–3.681
Job	23.21*	1.798	23.47	1.291	20.60	1.330
Adjusted R^2	0.291		0.232		0.286	

Note: OLS regression. The dependent variable is the trading frequency (Trading) per year. 2021 represents the year when VNindex increases, and 2022 represents the year when VNindex decreases. The main variables S_Time, S_Duration, S_Wake represent the sleep onset time, duration, and number of awakenings during the night, respectively. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5 examines the impact of variables on stock transaction frequency. The coefficient of the variable S_time is not statistically significant in both 2021 and 2022, nor during the entire study period. This suggests that there is no significant relationship between the time at which investors go to sleep in the evening and their trading frequency across different stages of the research. When examining evening sleep duration, we find that the coefficient of the S_Duration variable is positively and statistically significant at the 5% level in 2021 and throughout the entire study period but not in 2022. This indicates a general trend where sleep duration affects investors' trading frequency in the same direction. In other words, investors tend to trade more when they sleep longer at night, especially when the market experiences price increases. This result once again reinforces the findings from the previous Table 4 but completely rejects the previously stated hypothesis, H1. But during market declines and the resulting pervasive pessimism, the impact of sleep duration on investors' trading frequency becomes insignificant. S_Wake, which represents the number of times waking up during the night, remains statistically significant across all study periods. This underscores the importance of nighttime awakenings in influencing trading behavior. Investors with poor and intermittent sleep quality tend to trade less. Due to climate and cultural differences between Eastern and Western countries, midday naps are quite popular in Vietnam and China. To study these naps, we use a dummy variable called S_Mduration, which takes values of 1 and 0. This variable helps differentiate between individuals who take midday naps and those who do not. The results indicate that individuals who take midday naps traded 31.62 times more in 2021, 26.83 times more in 2022, and 28.43 times more over the entire study period compared to those who do not nap. In sum, our findings reject H1, which states that sleep-deprived investors will increase their trading. We explain that investors who sleep better will have better mental clarity, improving their ability to receive and analyze information. This increased mental clarity makes them more confident in predicting stock prices and increases their trading frequency and trading capacity.

Control variables like investment experience, return, and stock holding period are all significant in explaining trading frequency. In particular, an increase in investment experience

leads to a decrease in transaction frequency. Longer holding periods correspond to less frequent transactions. Likewise, there is an inverse relationship between return and trading frequency, as increased trading incurs higher transaction costs, reducing investment efficiency. These findings align with previous research (Isaenko, 2023; Boguth et al., 2016). Other explanatory variables such as education level, number of stocks in portfolio, and job do not show statistical significance.

Table 6. Examine the marginal impact on investor groups with varying trading frequencies

Variable	Trading_L		Trading_M		Trading_H	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
Panel A. Year 2021						
S_Time_L	23.56%	1.334	19.31%	1.484	18.72%	1.524
S_Time_M	24.40%	0.933	12.73%	0.927	21.02%	1.137
S_Time_H	–20.11%	–1.531	–24.52%	–1.239	–16.55%	–1.004
S_Duration_L	18.53%**	2.360	16.67%**	2.542	–15.68%**	–2.889
S_Duration_M	13.54%*	1.930	–18.38%**	–2.301	17.11%	1.345
S_Duration_H	–21.70%**	–2.674	–19.49%**	–2.172	23.63%***	3.756
S_Wake_L	–13.30%***	–3.209	10.38%*	1.839	19.28%***	3.455
S_Wake_M	–15.51%***	–3.231	13.16%*	1.810	13.40%***	3.038
S_Wake_H	17.98%***	3.552	–13.44%*	–1.784	–17.73%**	–2.339
S_Mduration_0	13.37%**	2.492	10.22%*	1.719	–17.41%***	–3.019
S_Mduration_1	–15.94%**	–2.194	–12.78%*	–1.801	11.51%**	2.443
Panel B. Year 2022						
S_Time_L	22.45%	1.337	18.11%	1.374	19.12%	1.304
S_Time_M	23.48%	0.783	12.60%	0.777	20.17%	1.227
S_Time_H	–20.61%	–1.601	–23.42%	–1.262	–16.48%	–1.214
S_Duration_L	19.13%**	2.493	16.99%**	2.573	–16.18%**	–2.359
S_Duration_M	12.14%*	1.820	–19.35%**	–2.621	17.48%	1.205
S_Duration_H	–19.75%**	–2.104	–18.29%**	–2.352	22.61%***	3.886
S_Wake_L	–13.42%***	–3.059	10.20%*	1.969	19.58%***	3.473
S_Wake_M	–15.41%***	–3.273	13.26%*	1.901	13.53%***	3.128
S_Wake_H	17.23%***	3.352	–13.47%*	–1.703	–17.46%**	–2.429
S_Mduration_0	13.57%**	2.455	10.25%*	1.579	–18.41%***	–3.579
S_Mduration_1	–15.84%**	–2.224	–12.64%*	–1.823	11.56%**	2.466
Panel C. Two years (2021–2022)						
S_Time_L	24.45%	1.311	19.41%	1.504	17.92%	1.305
S_Time_M	25.21%	0.133	12.90%	0.767	21.07%	1.354
S_Time_H	–20.85%	–1.432	–24.10%	–1.244	–14.31%	–1.116
S_Duration_L	17.57%**	2.540	16.78%**	2.182	–15.16%**	–2.661
S_Duration_M	13.49%*	1.810	–18.50%**	–2.338	17.38%	1.416
S_Duration_H	–21.48%**	–2.771	–19.03%**	–2.248	24.53%***	3.143
S_Wake_L	–13.36%***	–3.206	10.55%*	1.999	19.17%***	3.493

End of Table 6

Variable	Trading_L		Trading_M		Trading_H	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
S_Wake_M	–15.58%***	–3.305	13.64%*	1.990	13.85%***	3.178
S_Wake_H	17.12%***	3.582	–13.54%*	–1.982	–17.74%**	–2.549
S_Mduration_0	12.48%**	2.682	11.12%*	1.842	–17.08%***	–3.822
S_Mduration_1	–16.02%**	–2.333	–12.47%*	–1.874	12.54%**	2.055

Note: Logit regression. The dependent variable is the trading frequency (Trading) per year. 2021 represents the year when VNindex increases, and 2022 represents the year when VNindex decreases. The main variables S_Time, S_Duration, S_Wake represent the sleep onset time, duration, and number of awakenings during the night, respectively. Investors are categorized into three groups (L, M, and H) based on various variables, with L representing the lowest values, M the middle values, and H the highest values. The variable S_Mduration_1 denotes investors who take midday naps, while S_Mduration_0 represents those who do not take midday naps. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

To perform a robustness check on the model, Table 6 examines the marginal impact on groups of investors with varying trading frequencies. The results in Panel A of Table 6 are consistent with those in Table 5, indicating no significant relationship between trading frequency and investors' sleep onset time. The three variables, S_Time_L, S_Time_M, and S_Time_H, all show statistical insignificance. When analyzing variables related to sleep duration, we observe that investors' probability of falling into the low trading activity group increases by 18.53% with a short sleep duration, while it decreases by 21.70% with a long sleep duration. Conversely, the probability of investors falling into the high trading activity group increases by 23.63% with a long sleep duration and decreases by 15.68% with a short sleep duration. These findings suggest that investors who sleep longer have a higher likelihood of belonging to the high trading activity group, while those with shorter sleep times are more likely to belong to the low trading activity group. These results further corroborate the findings in Tables 4 and 5.

When examining the variable related to the number of times waking up during the night (sleep quality), we find that an investor's probability of belonging to the lowest trading group decreases by 13.30% with good sleep quality (few night awakenings) and increases by 17.98% with poor sleep quality (frequent night awakenings). Conversely, the probability of an investor falling into the high trading frequency group increases by 19.28% with good sleep quality and decreases by 17.73% with poor sleep quality. In summary, investors with good sleep quality (few night awakenings) have a higher probability of belonging to the high-frequency trading group than investors with poor sleep quality (many night awakenings). Analyzing the midday napping variable further, the results show that if investors are people who do not take midday nap, the probability that they are in the low trading group will increase to 13.37%. Conversely, if investors are midday nappers, the probability that they are in the group with low trading frequency will decrease by 15.94%. If investors do not take midday nap, the probability that they are in the high trading group will decrease by 17.41%, and if they are midday nappers, the probability that they are in the high trading frequency group will increase by 11.51%. In other words, investors who take midday nap have a higher trading frequency than investors who do not take midday nap. The above results do not show any major differences between different research periods when the stock market increases (Panel A) or decreases (Panel B), or for the entire period of 2021 and 2022 (Panel C)

4.3. Sleep and the average number of stocks in portfolio

Next, we divide investors into three groups based on their trading frequency: active investors, who have a high trading frequency; passive investors, who have a low trading frequency; and investors with an average trading frequency. We then perform regression with the dependent variable being the average number of stocks in the portfolio per year. The results in Panel A of Table 7 show that for passive investors, increased sleep duration causes the number of stocks held in the portfolio to decrease during bull market years. This finding is inconsistent to hypothesis H1. The results are similar for the group of investors with average trading frequency. However, the result is opposite for the group of active investors. Specifically, the coefficient of the S_Duration variable in the group of active investors reached a positive 8.334, showing a positive impact between sleep duration and the number of stocks in the portfolio during bull market periods, this result is consistent with hypothesis H1. This can be understood that when the stock market increases, quality sleep is essential for maintaining cognitive functions such as decision-making, problem-solving, and risk assessment. Being well-rested can help active investors make sound investment decisions and evaluate potential stocks more effectively, leading to greater confidence in their choices and a willingness to diversify their portfolio by holding a larger number of stocks. But in a bearish market (Panel B), it is especially interesting that passive investors will hold more stocks if their sleep duration increases (8,792). Meanwhile, active investors have a negative relationship between the number of stocks held and the duration of sleep (–7.372). This result is consistent with Venkatraman et al. (2007), who stated that lack of sleep causes investors to proactively increase risky behaviors, thereby increasing their purchases of risky assets such as stocks instead of investing in low-risk assets such as bonds or treasury bills.

Table 7. Examine how various variables impact the number of stock held by different investor groups

Variable	Trading_L		Trading_M		Trading_H		All investors	
	HN		HN		HN		HN	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
Panel A. Year 2021								
S_Time	31.23	0.490	24.59	1.201	36.93	1.103	28.30	1.324
S_Duration	–6.402**	–2.103	–7.142*	–1.873	8.334**	2.425	6.457	1.630
S_Wake	34.67***	3.595	42.11***	3.784	28.16***	4.125	35.10***	3.241
S_Mduration	3.553*	1.823	2.456**	2.457	4.294*	2.001	3.851**	2.104
Exper	2.464*	1.727	1.930*	1.933	1.039**	2.046	1.985*	1.930
Edu	12.59	0.393	14.68	1.039	11.84	1.044	13.58	1.550
Return	–3.453**	–2.727	–3.100**	–2.935	–1.392**	–2.104	–2.919**	–2.933
HP	32.21	1.330	28.41	0.383	29.47	0.822	30.29	1.393
Job	2.453***	3.417	2.650***	3.434	1.875**	2.681	2.748**	2.437
Panel B. Year 2022								
S_Time	27.23	1.447	26.28	1.355	33.17	1.153	23.34	1.083
S_Duration	8.792**	2.165	7.100*	1.950	–7.372**	–2.449	7.477**	2.590
S_Wake	37.35***	3.048	43.67***	3.354	25.40**	2.455	34.13**	2.111

End of Table 7

Variable	Trading_L		Trading_M		Trading_H		All investors	
	HN		HN		HN		HN	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
S_Mduration	–3.574*	–1.673	–2.906**	–2.822	–4.222*	–2.076	–2.104**	–2.434
Exper	2.847*	1.937	1.930**	2.483	1.039**	2.676	1.849*	1.740
Edu	14.09	0.443	14.22	1.179	12.46	1.164	12.67	1.583
Return	–4.467*	–1.857	–3.469	–1.025	–1.348	–1.170	–2.774**	–2.263
HP	34.41	1.180	21.36	0.689	29.12	1.462	31.10	1.513
Job	2.183**	2.420	2.330***	3.091	1.800***	3.591	3.662**	2.491
Panel C. Two years (2021–2022)								
S_Time	30.22	0.932	25.02	1.442	35.13	1.304	25.30	1.246
S_Duration	6.302**	2.129	7.780*	1.780	–6.312**	–2.215	7.424**	2.120
S_Wake	31.25***	3.443	42.79**	2.300	25.35**	2.410	33.69**	2.351
S_Mduration	–3.451*	–1.900	–2.911***	–3.899	–4.063*	–1.971	–2.002***	–3.130
Exper	2.794**	2.117	1.981*	1.843	1.569**	2.886	2.655**	2.140
Edu	13.33	1.073	14.94	1.285	12.41	1.004	12.84	1.409
Return	–3.227	–1.551	–3.319*	–1.945	–2.310**	–2.115	–2.554**	–2.104
HP	33.99	1.214	25.31	0.779	29.18	1.062	30.29	1.048
Job	2.494**	2.401	2.583***	3.504	1.975***	3.103	3.356**	2.111

Note: OLS regression. Investors are divided into 3 groups according to tertile: low trading (Trading_L), average trading (Trading_M) and high trading (Trading_H). The dependent variable is the average number of stocks held in the portfolio each year (HN). 2021 represents the year when VNindex increases, and 2022 represents the year when VNindex decreases. The main variables S_Time, S_Duration, S_Wake represent the sleep onset time, duration, and number of awakenings during the night, respectively. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The coefficient of the variable S_Wake is positive and statistically significant in all groups of investors and at different stages of research, showing that the number of times waking up during the night positively affects the number of stocks held in the portfolio of all investor groups. That means the more times an investor wakes up, the more stocks they will hold in their portfolio, or in other words, investors who hold many stocks in their portfolio have poor sleep quality, and often wake up at night more frequently than investors with fewer stocks in their portfolio, regardless of whether the market goes up or down. This rejects hypothesis H1.

In Panel A, Table 7 shows that the variable S_Mduration for all investors is 3.851, significant at the 10% level. This means that during a rising market, investors who nap hold 3.851 more stocks than non-nappers. In a falling market (Panel B), the value is –2.104, indicating that napping investors hold fewer stocks than non-nappers. This suggests that naps enhance alertness and proactivity in trading, leading to more stock holdings in a rising market and more sales in a bearish market. Other significant variables affecting stock holdings include investment experience, return, and jobs in the finance sector.

4.4. Sleep and investor's return

Table 8, Panel A, examines the impact of variables on return rates for different investor groups during a bull market. We find no evidence of the sleep onset time and midday nap affecting the returns of various investors. But the coefficients of the variables S_Duration and S_Wake

of passive investors are statistically significant, specifically the coefficients of S_Duration = 0.030, S_Wake = –0.061. It proves that investors who sleep longer and wake up less often during the night will have higher return rates (This result supports hypothesis H2).

When we look at active investors (Trading_H), we cannot find that any sleep variables affected their return rates. Other explanatory variables, such as investment experience, length of time holding stocks, and job, are all significant in explaining an investor's rate of return. Specifically, the more experience an investor has, the higher their return rate. Additionally, the longer an investor holds shares, the higher their return rate. Furthermore, investors working in finance-related professions have higher rates of return compared to those working in other industries.

In Panel B, we analyzed the impact of variables on return rates for different investor groups during the year of market decline. In general, the results are consistent with those in Panel A. When comparing the three coefficients of the variables Exper, HP, and Job between active and passive investors, we observed that investment experience has a greater impact on the return rate of active investors than on passive investors (0.104 is greater than 0.068). However, stock holding time has a greater impact on passive investors' returns than on those of active investors (0.066 is greater than 0.060). Additionally, job's impact on return rates is also greater for passive investors compared to active investors (0.099 is greater than 0.080). Overall, our study is consistent with Han et al. (2023), demonstrating that sleep is an important factor in shaping investor behavior and investment performance.

Table 8. Analyze the impact of variables on return rates of different investor groups

Variable	Trading_L		Trading _M		Trading _H		All investors	
	Return		Return		Return		Return	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
Panel A. Year 2021								
S_Time	–0.016	–1.027	0.024	1.054	–0.050	–1.081	–0.073	–1.404
S_Duration	0.030**	2.648	–0.039*	–1.611	–0.030	–0.626	–0.038	–1.208
S_Wake	–0.061**	–2.232	0.019*	1.712	0.103	1.296	0.125	1.293
S_Mduration	0.006	0.483	0.034	0.788	0.043	0.924	0.019	1.003
Exper	0.094***	3.455	0.052**	2.485	0.074***	3.932	0.086**	2.785
Edu	–0.072	–0.785	0.142	0.457	–0.037	–0.891	–0.083	–0.702
HP	0.024***	4.049	0.048**	2.169	0.057**	2.819	0.049**	2.760
Job	0.151**	2.748	0.204**	2.048	0.091**	2.722	0.147**	2.118
Panel B. Year 2022								
S_Time	–0.024	–1.162	0.046	1.144	–0.075	–1.020	–0.103	–1.254
S_Duration	0.035**	2.778	–0.034*	–1.451	–0.036	–0.610	–0.033	–1.066
S_Wake	–0.081**	–2.535	0.014*	1.932	0.127	1.029	0.148	1.174
S_Mduration	0.015	0.420	0.056	0.712	0.046	0.764	0.023	1.333
Exper	0.068***	3.942	0.046**	2.545	0.104***	3.578	0.099**	2.640
Edu	–0.076	–0.771	0.342	0.736	–0.062	–0.822	–0.083	–0.637
HP	0.066***	4.001	0.148**	2.109	0.060**	2.209	0.079**	2.320
Job	0.099**	2.711	0.216**	2.044	0.080**	2.703	0.148**	2.658

End of Table 8

Panel C. Two years (2021–2022)								
S_Time	0.066	1.553	0.053	1.018	–0.052	–1.141	–0.153	–1.412
S_Duration	0.039**	2.130	–0.069*	–1.561	–0.035	–0.132	–0.021	–1.134
S_Wake	–0.069**	–2.930	0.032*	1.744	0.174	1.456	0.128	1.033
S_Mduration	0.026	0.223	0.024	0.818	0.043	0.023	0.028	1.046
Exper	0.088***	3.205	0.122**	2.065	0.072***	3.152	0.071**	2.255
Edu	–0.046	–0.746	0.167	0.407	–0.137	–0.824	–0.073	–0.783
HP	0.023***	4.030	0.135**	2.121	0.067**	2.649	0.064**	2.130
Job	0.241**	2.044	0.184**	2.141	0.093**	2.746	0.194**	2.104

Note: OLS regression. Investors are divided into 3 groups according to tertile: low trading (Trading_L), average trading (Trading_M) and high trading (Trading_H). The dependent variable is the return rate. 2021 represents the year when VN-index increases, and 2022 represents the year when VNindex decreases. The main variables S_Time, S_Duration, S_Wake represent the sleep onset time, duration, and number of awakenings during the night, respectively. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

4.5. Sleep and average holding period of stocks in the portfolio

In the Table 9, we analyzed the impact of sleep variables on the average stock holding time in the portfolio. The results show that for passive investors (low trading frequency), later bed-times cause investors to hold stocks for shorter periods (variable coefficient S_Time = –0.489 and statistically significant at the 5% level). Longer evening sleep duration causes investors to hold stocks for shorter periods (coefficient of variable S_Dration = –1.019 and statistically significant at the 1% level). The more times investors wake up during the night, the longer the average stock holding time is (the coefficient of the variable S_Wake = 0.533 and is statistically significant at the 10% level). These results all reject hypothesis H1. Investors who take naps hold stocks for 0.064 weeks longer than investors who do not take naps. This result supports hypothesis H2, indicating that good sleep quality leads to longer holding periods.

Table 9. Analyze the impact of variables on the average holding period of stocks in the portfolio for different investor groups

Variable	Trading_L		Trading_M		Trading_H		All investors	
	HP		HP		HP		HP	
	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio	Coef	T-ratio
S_Time	–0.489**	–2.038	–0.413	–1.568	0.662	1.203	–0.619	–1.254
S_Duration	–1.019***	–3.400	–1.110*	–1.880	1.307	0.737	–1.311	–0.595
S_Wake	0.533*	1.771	0.516	1.031	0.743**	2.380	0.930**	2.614
S_Mduration	0.064**	2.363	0.164**	2.109	0.104*	1.699	0.235*	1.719
Exper	–0.853*	–1.920	–0.853*	–1.920	–0.339	–1.550	–0.344	–1.510
Edu	0.095	1.103	0.095	1.190	0.113	1.193	0.127	1.195
Job	0.733	0.301	0.733	0.264	–0.748**	–2.751	–0.755*	–1.722

Note: OLS regresion. Investors are divided into 3 groups according to tertile: low trading (Trading_L), average trading (Trading_M) and high trading (Trading_H). The dependent variable is the average holding period of stocks in the portfolio (HP). The main variables S_Time, S_Duration, S_Wake represent the sleep onset time, duration, and number of awakenings during the night, respectively. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

There is no evidence of a link between education and job on the average portfolio holding period among passive investors.

For active investors, sleep time and duration show no significant relationship with the average holding period of stocks in the portfolio. However, the frequency of waking up during the night and the midday naps are both significant factors explaining the average holding period of stocks in the portfolio. Among the control variables, only the job variable has an impact on the average stock holding time in the portfolio of active investors. Specifically, investors working in the field of securities finance have a shorter average stock holding time than those in other fields. This may be attributed to the characteristics of the industry, which require them to trade more stocks.

In summary, our results show that sleep variables affect passive investors differently than active investors and also vary between bull market years and bear market years. Specifically, increased sleep duration leads passive investors to hold fewer stocks during bull markets and more stocks during bear markets. Increased sleep duration results in active investors holding more stocks during bull markets and fewer stocks during bear markets. Good sleep quality is positively associated with better investment performance for passive investors. Active investors' performance is less directly influenced by sleep quality, with experience and job-related factors playing a more significant role. Both afternoon naps and nighttime sleep affect the frequency of trading. Investors who take regular afternoon naps and have better nighttime sleep tend to trade less frequently. Poor sleep quality is linked to higher risk-taking behaviors. Investors with poor sleep are more likely to engage in risky investment strategies. Factors such as investment experience, job and time holding new stocks are the main factors determining the investment performance of active investors.

4.6. Robustness check

To ensure the robustness and validity of the findings presented in the preceding model, we have undertaken additional analyses employing different regression techniques, namely Principal Component Analysis (PCA), Partial Least Squares Regression (PLSR), and The Generalized Method of Moments (GMM). This rigorous approach aims to mitigate the potential influence of statistical anomalies or overlooked interpretations. Importantly, we have maintained the core parameters, including bedtime, sleep duration, frequency of nighttime awakenings, and naps, at their original values. Similarly, the dependent variables under consideration remain trading frequency, portfolio size, average holding period, and investor's rate of return. The results obtained through these alternative regression methods consistently align with those presented from Tables 4 to 9. This consistent pattern reinforces the overall reliability and robustness of our findings.

5. Conclusions

The benefits of good sleep have been extensively studied in various fields, including Medicine, Human Resource Management, Education, and National Defense. However, there has been a notable lack of research concerning how sleep quality influences the trading behavior of individual investors in the stock market. Our study sought to fill this gap by examining this relationship through a survey of 405 investors. Specifically, we assessed sleep quality based on factors such as sleep time, sleep duration, the frequency of nighttime awakenings, and the presence of midday naps. We employed various regression methods to ensure the accuracy of our findings.

In conclusion, our results confirm the influence of sleep on investors' trading behavior in the stock market. Investors' trading behaviors, such as the number of stocks held during different market conditions, are influenced by their sleep patterns. Improved sleep leads to more strategic stock holding patterns aligned with market conditions. Sleep deprivation negatively impacts emotions by increasing stress and anxiety, disrupting the body's self-regulation mechanisms. This results in heightened feelings of anxiety, anger, and stress, which can impair rational decision-making and objective analysis. Lack of sleep also diminishes emotional control, leading to overreactions in stressful situations and impulsive investment decisions. Prolonged fatigue reduces concentration and information processing abilities, exacerbating stress and decision-making difficulties. Consequently, sleep-deprived investors are more prone to making quick, impulsive trades without thorough consideration, increasing trading frequency and irrational behaviors. Poor sleep quality further impairs logical thinking and market analysis, heightening the likelihood of errors and poor investment performance, ultimately increasing financial risk. While some findings align with our initial hypotheses, others contradict them. We have endeavored to elucidate the disparities between our results and hypotheses, but certain discrepancies remain unexplained, representing a limitation of this article. Consequently, further research will be essential to fully understand these distinctions in the future.

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Author contributions

Luu Thu Quang conceived and designed the experiments, performed the experiments, analyzed and interpreted the data, and wrote the first draft of the manuscript. Tran Tuan Vinh performed the experiments, contributed reagents, materials, analysis tools, or data. Nguyen Dang Hai Yen support corresponding author to revised papers and responded to reviewers. Duong Dang Khoa analyzed and interpreted the data and wrote the first and final drafts of the manuscript.

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None of the authors have a conflict of interest to disclose.

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APPENDIX

Questionnaire	
Demographic questions	Gender of interviewee:
	Age of interviewee:
	Educational level of the interviewee:
	Family status of the interviewee:
	Interviewee's employment status:
Questions about trading activities	Number of years of experience investing on the stock market:
Questions about sleep	What time do you usually go to bed at night?
	How long do you sleep in total at night?
	What was the total time you spent midday napping?
	How many times do you wake up during the night?