

ChatGPT AND STRESS

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Abstract

ChatGPT is an artificial-intelligence chatbot. In addition to comprehending an image like a text prompt, it can understand complex prompts and exhibit human-level performance. It became the fastest-growing application in history, acquiring one million users within five days of release. However, despite its potential to improve productivity, job satisfaction, self-efficacy, and wages, it causes stress to individuals. This study examines the relationship between stress and ChatGPT in Thailand. Although stress is a severe health problem in the country, ChatGPT cannot be avoided as this application helps support the country's targeted digital technology industry. The study uses a proxy for unobserved stress levels and ChatGPT concerns using Google's search volume indexes. Based on daily samples from December 10, 2015, to May 31, 2023, regression analysis revealed that ChatGPT significantly increased stress levels. However, during the development sub-sample, the stress level decreased. Stress escalated in the early- and viral-use sub-samples, where the effect for the viral-use sub-sample was significantly higher. In the COVID-19 pandemic sub-sample, the effect was non-significant. The causality of ChatGPT in stress was confirmed by the contemporaneous-causality test.

Keywords: Artificial Intelligence, ChatGPT, Good Health and Well-Being, Stress

1. INTRODUCTION

1.1 Artificial Intelligence

Today, artificial intelligence (AI) is an integral part of modern business and individual lives. AI is defined as "the capacity of a computer, robot, or other programmed mechanical device to perform operations and tasks analogous to learning and decision-making in humans, as speech recognition or question answering" or "a computer, robot, or other programmed mechanical device having this humanlike capacity" (Dictionary.com, n.d.). AI is mainly used in healthcare, retail, manufacturing, life sciences, banking, and public sectors. It enhances capabilities in

automation, learning, legal assistance, risk notification, and research (Pannu, 2015; SAS Institute, 2022). Xu, Guo, and Huang (2021) conducted a textual analysis of product announcements, finding that, during the COVID-19 pandemic, AI significantly improved firms' competitiveness. Firms engaged with AI could increase their revenue faster than those that did not. The adoption of AI has increased significantly in recent years. A global survey by Chui et al. (2022) found that the adoption rate of AI was 20% in 2012, and is expected to increase to 50% by 2022.

1.2 Artificial Intelligence and Stress

Twenty-eight percent of the workforce in

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modern businesses are based on AI or AI-supported programs (Puaschunder, 2019). AI performs operations and tasks analogous to learning and decision-making in humans. It helps employees solve certain problems and raises productivity, job satisfaction, self-efficacy, and wages (Felten, Raj, & Seamans, 2023; Noy & Zhang, 2023; Pannu, 2015). Meanwhile, AI causes employees' stress as it leads to job displacement (Kuhnert, Sims, & Lahey, 1989), with firms exposed to AI tending to reduce their non-AI positions (Acemoglu et al., 2022). Moreover, various tasks traditionally performed by humans have now been replaced by AI (Krakowski, Luger, & Raisch, 2023).

Employees must adapt to AI when it is introduced in the workplace. However, some perceive interactions with AI technology as stressful (Hudiburg, 1989). Brad (1984) explained that the stress (technostress) results from users' inability to cope with new technologies in a healthy manner.

AI-induced wage increases could result in higher stress levels. French and Dunlap (1998) conducted a general-employee survey at six worksites in the U.S. 3–10% wage increases were associated with higher mental stress. These rising stress levels were explained by lost non-pecuniary job satisfaction and increased work efforts (Bryson, Barth, & Dale-Olsen, 2012).

Table 1 Event and Occurrence Date

Occurrence Date	Event	Event Description
December 10, 2015	OpenAI, the developer of ChatGPT, was established.	OpenAI is an AI-research corporation. Its business is to promote and develop user-friendly AI.
June, 2018	Original GPT (GPT-1) was released.	GPT-1 was a research project, whose objective was to demonstrate the capabilities of large-scale language models. Its use is free, but it is not publicly available.
February 14, 2019	GPT-2 was released.	GPT-2 generated coherent and realistic sequences of text. Moreover, it could generate human-like responses. OpenAI charged a fee for its use.
June 11, 2020	GPT-3 was released.	GPT-3 could generate coherent text, write computer code, and create art. It could understand the context of a given text and generate appropriate responses. It is a commercial service.
November 30, 2022	OpenAI launched ChatGPT.	ChatGPT can accept an image as input, understanding it like a text prompt. Its model better understands complex prompts and exhibits human-level performance on several professional and traditional benchmarks. It has both free and commercial versions.

Sources: Ali (2023), "ChatGPT" (2023), "Open AI" (2023), OpenAI (2023b).

Under certain conditions, AI can help reduce employee stress. For example, it can help employees to solve certain problems. In certain situations, problem-solving may not be possible without AI. Therefore, as stress can be caused by the inability to solve problems, it is reduced when problems are solved (Howard & Scott, 1965).

1.3 ChatGPT

On November 30, 2022, OpenAI, a U.S. AI research and development company, released ChatGPT to the public. ChatGPT is an AI chatbot that interacts with users conversationally using the dialog format. OpenAI (2023a) enables ChatGPT to answer questions, admit mistakes, challenge premises, and reject inappropriate requests. ChatGPT has attracted tremendous interest from users worldwide. It successfully acquired one million users within five days of its release, whereas Instagram and Spotify took 2.5 and five months, respectively, to acquire the same number of users (Hitakshi, 2023). Presently, ChatGPT has over 100 million users, and its website serves 1.8 billion monthly visitors (Duarte, 2023). Table 1 summarizes the events, event descriptions, and occurrence dates of OpenAI and ChatGPT.

ChatGPT offers a wide range of applications across industries, such as customer services, healthcare, and education (Haleem, Javaid, & Singh, 2022; Ray, 2023). In de Souza, de Andrade Neto, and Roazzi's (2023) IQ test for Brazil, ChatGPT achieved the highest score of 137 and was at the 99th percentile. The average scores for high school and doctoral graduates were 102.2 and 113.6, respectively.

Recently, Gartner Inc. surveyed 2,544 executives who participated in its webinar series in March and April 2023. 45% of participants answered that the publicity of ChatGPT urged them to invest more in AI, while 70% had explored the use of generative AI tools, including ChatGPT. Moreover, 68% believed that the benefits of generative AI outweighed the risks ("Gartner poll finds",

2023). In China, Chen et al. (2023) found that 28% of occupations in the current labor market require ChatGPT-related skills. In the future, 45% of the market will require these skills.

Like other AI technologies, ChatGPT has raised employee concerns regarding job security. According to Zarifhonarvar's (2023) estimation, 95, 60, and 20 occupations for professionals, technicians and associate professionals, and managers, respectively, suffer full impact from ChatGPT, where the tasks and skills associated with their jobs can be fully automated. The armed forces and elementary occupations experience the least impact. Stress should increase with the possible ChatGPT-induced job displacement. Technostress and high-wage stress should also increase. ChatGPT is new and emerging; thus, stress—including technostress and high-wage stress—could increase because of possible ChatGPT-induced job displacement. Therefore, employees must learn and adopt ChatGPT to be effective and efficient in a dynamic work environment (Biswas, 2023). Mok (2023) reports that businesses pay higher wages to employees with ChatGPT skills. Regarding stress reduction, ChatGPT should help employees via the same mechanisms as other AIs.

1.4 Research Issue

ChatGPT is useful and is increasingly being adopted by industries in most countries worldwide ("Gartner poll finds", 2023); thus employees are likely to experience increased stress. Stress is an important global health concern, and the World Health Organization (WHO) has classified it as a health epidemic of the 21st century (Fink, 2016). WHO estimates that 12 billion working days are lost annually due to poor mental health—this loss is equivalent to 1 trillion dollars in lost productivity ("Mental health at work", 2022).

This study examines the effects of ChatGPT on stress. Thailand, which is among the 163 countries where OpenAI offers ChatGPT (OpenAI, n.d.), was selected as the sample county for this study. In May 2023,

the country had 1.31 million ChatGPT visitors and 10.26 million visits. The page per visit and visit duration were 4.79 pages and 8:37 minutes, respectively. In the U.S., India, and Japan, the top three ChatGPT-user countries, the visit durations are 7:02, 7:00, and 8:02 minutes, respectively (Similarweb, 2023).

This study chose Thailand for four reasons. First, Thailand is one of the countries suffering from high levels of stress at the rate of 46% of the population (“Mintel: About 8 in 10”, 2022). Second, the Thai are early adopters of new technologies. The combined first- and second-wave adopters accounted for 33%, whereas those in the U.S. and Japan accounted for 33% and 22%, respectively (YouGov, 2022). Moreover, in a survey conducted after the COVID-19 pandemic, 52% of the respondents answered that they sped up AI-adoption plans, and 86% believed that AI would be a mainstream technology at their firms (Kate, 2021). Third, Thailand is shifting its economy from manufacturing to knowledge-based industries. Digital technologies are among the target industries (Sharon, 2019a). Therefore, the country requires AI strategies to support this transition (Sharon, 2019b). Fourth, a survey by WISESIGHT (THAILAND) found that 14% of respondents had negative views regarding ChatGPT—job displacement being one of their concerns (“Trends revealed”, 2023).

As stress levels and ChatGPT concerns are unobserved, Google search volume indexes (SVIs) were used to proxy for the two variables to estimate their relationship. Eysenbach (2011) explained that individuals actively relay information about their identities, thoughts, and behaviors when searching on Google. Furthermore, individuals search on Google only for the information they prefer (Da, Engelberg, & Gao, 2011).

The query for stress is the Thai word *เครียด* (*Kherīyd*). Ayers et al. (2012) employed *stress* queries to measure stress levels. The query *Chat GPT* measures the concerns of ChatGPT. This study chooses the *Chat GPT* query over *ChatGPT* (Kao, 2023) and *Chatgpt* (Ante & Demir, 2023) queries as

these two queries are much less popular than those of *Chat GPT*. Over the 12 months before June 2023, the average SVI for the *Chat GPT* query was 40 points, while those for the *ChatGPT* and *Chatgpt* queries were 34 points (“Explore”, n.d.).

2. METHODOLOGY

2.1 The Model

This study linearly relates stress (S_t) and ChatGPT (G_t), as shown in Equation (1).

$$S_t = \alpha + \beta G_t + e_t, \quad (1)$$

where α and β are the intercept and slope coefficient, respectively. The variable e_t is the error term. This study is aware that this relationship is not linear. If it is nonlinear, Equation (1) can be used. This equation is interpreted as a linear approximation of a non-linear relationship.

2.2 Estimation and Endogeneity Problems

Equation (1) is a univariate linear regression equation. This can be estimated using the traditional ordinary least-squares (OLS) regression technique. However, Equation (1) likely suffers from an endogeneity problem resulting from errors-in-variable and omitted-variable causes; OLS regressions yield biased and inconsistent estimates (Greene, 2018). The errors-in-variable cause is explained by the fact that the stress and ChatGPT variables are proxied by their corresponding SVIs. The proxies are the sum of the true levels and errors. Since stress was the dependent variable, its measurement error had no effect on bias or inconsistency. Bias and inconsistency resulted from measurement errors in the independent ChatGPT variables. Regarding the cause of the omitted variable, it is unlikely that stress was exhaustively explained by ChatGPT. Other explanatory variables are, for example, a pandemic (Boals & Bank, 2020), financial problems (Bailey et al., 1998), and illness (Steptoe, 1991).

This study resolves endogeneity problems in estimation using the generalized method of moments (GMM) regression instead of OLS regression. The GMM is an instrument-variable (IV) regression technique that returns consistent, asymptotically normal, and efficient estimates, even for a non-normal variable specification (Hansen, 1982). This study employs Racicot and Théoret's (2010) two-step technique to construct the IVs. Pal's (1980) IVs are the inputs for the first step. This technique has provided informative and valid IVs in previous studies (e.g., Khanthavit, 2022).

2.3 Hypothesis Test

Following Equation (1), if ChatGPT does not affect stress, the slope coefficient β will be zero. A significant and positive β suggests that ChatGPT raises the stress level, whereas a significant and negative β would indicate lowered stress. ChatGPT can raise or lower stress; the coefficient β represents the net effect. This study conducted hypothesis tests using a t test. The t statistic is computed from Newey and West's (1987) heteroskedasticity and autocorrelation-consistent (HAC) standard deviations.

3. THE DATA

3.1 Sample Period

The sample consisted of daily data, beginning December 10, 2015, and ending May 31, 2023 (2,730 observations). December 10, 2015, was chosen for the first

observation as OpenAI was established on that day, and the development of ChatGPT began. The final observation for this study was taken on May 31, 2023.

3.2 The Variables

The stress and ChatGPT variables were proxied by Google's SVI's for queries of *เครียด* (Kherīyd) and *Chat GPT* respectively. The SVIs were retrieved from <https://trends.google.com/trends/>. The raw SVIs were de-trended by the logged time trend before they were de-seasonalized by day-of-the-week and month-of-the-year dummies. Finally, the de-trended and de-seasonalized variables were standardized using their averages and standard deviations.

3.3 Descriptive Statistics

Table 2 presents the descriptive statistics for the stress and ChatGPT variables. The stress variable was negatively skewed, while the ChatGPT variable was positively skewed. Their excess kurtoses suggest that the two variables are fat-tailed. The normality hypothesis was therefore rejected by the Jarque-Bera test at the 99% confidence level. The first-order autoregressive coefficients were positive and significant. The Diskey-Fuller tests ensured the stationarity property of the two variables.

The fact that the stress and ChatGPT variables were non-normal does not affect the GMM. GMM estimates are consistent, asymptotically normal, and efficient estimates (Hansen, 1982). The serially correlated

Table 2 Descriptive Statistics

Statistic	Search Volume Index	
	<i>Kherīyd</i> Query for Stress	<i>Chat GPT</i> Query for ChatGPT
Average	0.0000	0.0000
Standard Deviation	1.0000	1.0000
Skewness	-0.0040	1.7265
Excess Kurtosis	0.6684	32.0744
First-Order Autocorrelation	0.3583***	0.9632***
Jarque-Bera Statistic	50.8146***	1.18E+5***
Dickey-Fuller Test	-35.8889***	-6.6888***

Note: *** denotes significance at the 99% confidence level

stress and ChatGPT variables supported the use of HAC standard deviation in the *t* test.

4. EMPIRICAL RESULTS

Table 3 presents the effects of ChatGPT on stress in Thailand for the full sample and three sub-samples. Significant effects are inferred from the significance of the coefficient β .

4.1 Full Sample

Column 1 of Table 3 presents the results for the full sample (December 10, 2015, to May 31, 2023). The coefficient is 0.0412 and is significant at the 99% confidence level. When ChatGPT increases by one unit, stress also increases by 0.0412 units. This finding suggests that ChatGPT increases stress levels in the Thai workforce.

4.2 Sub-samples

The full sample was divided into three sub-samples to verify the effects during different periods of ChatGPT’s life. In the estimation, the variables were standardized for each period so that the sizes of the coefficients could be compared.

4.2.1 Development Sub-sample

The development sub-sample ranged from December 10, 2015, to February 12, 2019. OpenAI began its business and ChatGPT development on December 10, 2015. The company launched its first version of ChatGPT (GPT-1) in June 2018. The GPT-1 project was conducted for research purposes only. GPT-1 ended on February 13, 2019, and GPT-2 was released on February 14, 2019.

Column 2 of Table 3 presents the results for the development subsample. Interestingly, the coefficient is -0.1339, which is significant at the 99% confidence level. In this subsample, ChatGPT helped reduce stress levels. A possible explanation for this reduction is due to the dominant stress-reducing effect.

Tolan et al. (2021) measured AI exposure scores for various occupations. The first five occupations with the highest scores were (i) electronechnology engineers; (ii) database and network professionals; (iii) software and applications developers and analysts; (iv) engineering professionals (excluding electronechnology engineers); and (v) mathematicians, actuaries, and statisticians. These professionals tend to be the first to reach for and benefit from AI. ChatGPT would help them solve their problems and make their work more convenient and efficient; therefore, resulting in a decrease in their stress levels.

4.2.2 Early-use Sub-sample

OpenAI has gradually and successfully improved GPT. On February 14, 2019, GPT-2 was released and less than one-and-a-half years later, on June 11, 2020, GPT-3. GPT-2 and GPT-3 were sold to users. GPT-3 was replaced by ChatGPT on November 30, 2022. Therefore, in this study, the early-use subsample for GPT was identified as the period from February 14, 2019, to November 29, 2022. In Column 3 of Table 3, the coefficient for the sub-sample is 0.0774, and is significant at the 95% confidence level. Employees became more stressed when GPT use became more extensive and they were required to learn how to include the tool in their work, seeing the potential for disrupting their traditional capabilities.

Table 3 Effects of ChatGPT on Stress

Full Sample (12/10/15 to 5/31/23)	Sub-sample		
	Development (12/10/15 to 2/13/19)	Early Use (2/14/19 to 11/29/22)	Viral Use (11/30/22 to 5/31/23)
0.0412***	-0.1339***	0.0774**	0.3539***

Note: ** and *** denote significance at the 95% and 99% confidence levels, respectively.

4.2.3 Viral-use Sub-sample

ChatGPT became globally viral when launched by OpenAI on November 30, 2022. It is the fastest-growing application in history (Hu, 2023). Thailand, also experiencing its viral property, reported 1.31 million visitors in May 2023. In this study, the viral-use sub-sample ranged from November 30, 2022, to May 31, 2023. Column 4 of Table 3 provides the results for this sub-sample. The coefficient is 0.3539, and is significant at the 99% confidence level, and much larger than that for the early-use sub-sample. The size difference of 0.2765 is significant at the 99% confidence level. The stress level increased when ChatGPT became universally accessible. Users acknowledged its high human-like capabilities and ability to replace humans in many job functions and industries. This finding is consistent with the survey results of WISESIGHT (THAILAND), which showed that 14% of respondents feared losing their jobs to ChatGPT (“Trends revealed”, 2023).

The results for the full sample and sub-samples suggest that ChatGPT significantly affects stress levels, lowering stress only in the developmental state. However, when available in the market, ChatGPT becomes a threat; thus, stress levels increased with the increasing use of ChatGPT.

5. DISCUSSION

5.1 Robustness Check

5.1.1 Different Time Periods for Sub-samples

In the research phase, GPT-1 was not limited to laboratory experiments but was used in real operations. An alternative choice for the early-use sub-sample is from February 14, 2019, to November 29, 2022, to include

the GPT-1 period. The resulting development sub-sample was modified to a period from December 10, 2015, to February 13, 2019, to exclude GPT-1’s period. To check for robustness, Equation (1) was used to determine estimates for the newly defined periods for the two sub-samples. Columns 1 and 2 of Table 4 display the results, and are similar to those of the corresponding sub-samples in Table 3.

It is noticed that the coefficient (-0.0818) for the development sub-sample, when GPT-1 was excluded, is less negative than that (-0.1339) when GPT-1 was included. The coefficient (0.1602) for the early-use sub-sample in Table 4 is larger than that (0.0774) in Table 3. These size differences imply that Thai users perceived GPT-1 as being in the development stage and that GPT would benefit them.

5.1.2 Alternative Estimation Techniques

This study employed a GMM regression to estimate Equation (1). The IV was constructed using Racicot and Théoret’s (2010) technique, with Pal’s (1980) IV as the input. Alternative estimation techniques can also be used. To ensure that the result is not technique-dependent, Equation (1) was used to re-estimate the coefficients using OLS and GMM regressions with Durbin’s (1954) input. Columns 4 and 5 present the OLS and GMM results, respectively. For the full sample, the estimates for the two techniques were similar to those in Column 1 of Table 3.

5.1.3 Alternative Search Query

This study chose *Chat GPT* SVI to represent the ChatGPT variable. *Chat GPT* queries are particularly popular in Thailand. Previous studies conducted in other countries used *ChatGPT* or *Chatgpt* queries. The *ChatGPT*

Table 4 Robustness Check

Sub-sample			Estimation Technique		
Development (12/10/15 to 2/13/19)	Early Use (2/14/19 to 11/29/22)	COVID-19 (4/3/20 to 9/30/22)	OLS	Durbin’s (1954) IV	<i>ChatGPT</i> Query
-0.0818*	0.1602***	0.0193	0.3662***	0.4836***	0.4492***

Note: * and *** denote significance at the 90% and 99% confidence levels, respectively.

query was considered as an alternative and its SVI used to re-estimate Equation (1). The objective of this was to verify whether the result is sensitive to the choice of search query. Column 6 of Table 4 presents the corresponding results. The coefficient was significant at 0.4492. This is consistent with the results for the *Chat GPT* query shown in Table 3.

5.2 COVID-19 Pandemic

COVID-19 was a global health crisis, which caused a 25% increase in the prevalence of anxiety and depression worldwide (“COVID-19 pandemic”, 2022); thus, people were more stressed. More attention has been paid to COVID-19 than other matters during the COVID-19 pandemic (Xu, Zhang, & Zhao, 2023). It would be interesting to examine how COVID-19 affected the relationship between stress and ChatGPT. A pandemic sub-sample from April 3, 2020, to September 30, 2022, was employed in the estimation of Equation (1). April 3, 2020 was chosen as the first day of the pandemic because this was when the Thai government imposed its first curfew to contain the spread of the disease (“Curfew starts on Friday”, 2020). On September 30, 2022, the country reclassified COVID-19 from a dangerous communicable disease to a communicable disease under surveillance. Hence, this date is considered the end of the pandemic in Thailand (“Thailand ends COVID-19”, 2022).

Column 3 presents the results for the COVID-19 pandemic. The coefficient is 0.0193, and is non-significant. This non-significant result could be explained by the fact that during this period, significant attention was shifted to COVID-19 (Xu et al., 2023). The effect disappeared.

5.3 Contemporaneous Causality

There is a causal relationship between ChatGPT and stress. Equation (1) implies the causality of ChatGPT on stress based on the significant correlation between the two

variables. However, the causal relationship was not tested. This study employed a directed acyclic graph (DAG) (Swanson & Granger, 1997) to test the contemporaneous causality. If ChatGPT causes stress, DAG necessarily exhibits the relationship ($G_t \rightarrow S_t$). The test supports the relationship ($G_t \rightarrow S_t$) at the 99% confidence level.

6. CONCLUSION

ChatGPT—an AI chatbot that conversationally interacts with the user—has become the fastest growing application, acquiring one million users within five days. Further, it significantly benefits industries, such as customer service, healthcare, and education. ChatGPT has higher IQ scores than those of average doctoral graduates. With its humanlike capabilities, employees fear losing their jobs to ChatGPT. As a result, their stress levels increase, while there are further increases from technostress when employees must learn how to use a new application.

This study examined the effects of ChatGPT on stress in Thailand. The unobserved stress level and ChatGPT concern were proxied using Google’s SVIs. Using a sample from December 10, 2015, to May 31, 2023, regression analysis revealed that ChatGPT significantly increases the stress level of Thai employees. In the development sub-sample, however, stress was lowered probably because users in the research project, as well as potential early users, perceived ChatGPT as a tool to help them solve problems. In the early- and viral-use sub-samples, ChatGPT adversely affected stress. The effect was significantly higher in the current sub-sample of viral use; it was non-significant for the COVID-19 sub-sample. The contemporaneous-causality test ensured that significant stress effects were caused by ChatGPT.

The high-stress effect of ChatGPT occurred during the viral-use sub-sample. The sub-sample during November 30, 2022, to May 31, 2023, is a short period of time. ChatGPT is relatively new and probably not

well understood. Misperception and fear of the unknown could be the root cause of increased stress. This issue is left for future research.

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