Effects of Social Media on Religious Belief: Causal Machine Learning Approach[*]

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Abstract

This work investigates the causal effects of social media on religious belief, life belief, and life motivation using causal machine learning methods. While most methods for causal inference (e.g. difference-in-differences or regression discontinuity) are designed for panel data with time dimension, few methods are created for exploring causal inference using observational data collected at one point of time. Fortunately, current advanced methods in causal machine learning allow us to quantify causes and effects using observational data. In this work, we quantify a case study related to the Thich Minh Tue (TMT) phenomenon, which is a hot debate topic in Vietnam and other countries recently. We design an online survey to obtain the observational data. Our result shows that social media (e.g. YouTube, Tiktok, Facebook, and Zalo), as the *first* as well as the *main* platforms that people know and follow the TMT phenomenon, causally positively impact on Buddhism belief, life belief, and motivation to practice five precepts of Buddhism (not killing, not stealing, not misusing sex, not engaging in false speech, and not indulging in intoxicants). These causal effects are generally consistent and robust. Our results imply the special role of social media against other traditional channels of communication (e.g. television, news, magazine, family and friends) on religious and social phenomena.

Keywords: Social media, Thich Minh Tue phenomenon, Religious belief, Life belief, Life motivation, Causal machine learning.

1 Introduction

Causal relationships are very common in both life and science. However, detecting these causal relationships with solid results requires formal methods rather than simple reasoning. This work employs some current advanced causal machine learning methods to study the Thich Minh Tue (TMT) phenomenon, which is a hot topic on social media in Vietnam and other countries.

Thich Minh Tue is a well-known Buddhist devotee and "wandering monk" (or itinerant monk) in Vietnam in recent years. He walked from the South to the North of Vietnam and backward many times before but did not receive attention by social media. In late Spring and early Summer 2024, he has walked another tour[1]. This tour is completely different compared to any tours he did before in which massive social media (e.g. YouTubers and Tiktokers) keep a very close watch (almost 24/7) on him and makes him an internet sensation in Vietnam, with large crowds following him and spreading his image across prevalent social media platforms.

During his journey, Thich Minh Tue attracts numerous followers who willingly accompany him. Despite repeatedly clarifying that they were not his disciples, he welcomed their voluntary participation. Thich Minh Tue often found himself interrupted by individuals eager to take photos and record videos of him, which further magnified his online presence.

This study investigates how the TMT phenomenon, amplified by social media, has influenced the general public's perception of religion. It is important to note that even though our work uses the case study of Monk Thich Minh Tue, it is flexible to apply our techniques and methods to study other phenomena such as music singers (e.g. Taylor Swift with the Era tour) or climate activists (e.g. Greta Thunberg for urging world leaders to promptly address and reduce the impacts of climate change caused by human activity).

According to DataReportal, Vietnam boasts a thriving social media landscape with over 72.7 million users, translating to a staggering 73.3% of the population as of early 2024 [17]. This widespread adoption can be attributed to the rapid digitalization of the country, with affordable internet-enabled devices becoming increasingly accessible. The Vietnamese social media scene is not dominated solely by global giants. While Facebook, YouTube, and TikTok hold strong positions, a homegrown platform called Zalo has emerged as a major player, particularly in the messaging domain.

Beyond the realm of social connection and entertainment, social media has become a primary source of news and information for a significant portion of the Vietnamese population. This pervasive influence has fundamentally reshaped information consumption habits and public discourse. Social media platforms now serve as thriving spaces for open exchange, fostering widespread discussions on important societal issues. Notably, these platforms have empowered individuals to express their opinions with a relatively unconstrained voice, a stark contrast to traditional communication channels.

This dynamic social media landscape has ushered in a new era of religious discourse in Vietnam. Traditionally, religious practices and beliefs were often passed down through families and communities. However, with the rise of social media platforms, the distribution of religious information and viewpoints has become more open.

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[1]See https://baophapluat.vn/thong-tin-chinh-thuc-ve-su-thich-minh-tue-post512767.html.

Several religious organizations and figures are utilizing social platforms as a means to connect with supporters and spread their beliefs. This newfound accessibility has the potential to significantly impact how Vietnamese people perceive and engage with religion, and even their broader outlook on life. To further illustrate this dynamic, the phenomenon concerning monk Thich Minh Tue is a fitting example that highlights the power of social media to spark nationwide conversations about religion and religious teachings. By examining the viewpoints surrounding his pilgrimage, the extent of online platforms' influence on Vietnamese's perception of religion and life as a whole will become evident.

The remainder of the paper is organized as follows. Section 2 discusses previous work on social media and religious belief, life belief, and life motivation. Section 4 describes the data sampling, variables, and some exploratory data analysis. The causal estimation methods are summarized in Section 3. We present all results in Section 5 and conclude our work in Section 6.

2 Literature Review

2.1 Social Media and Religious Belief

The intersection of social media and religious belief has garnered increasing attention in academic research over the past decade. Social media platforms have become vital spaces where religious practices, beliefs, and identities are expressed, negotiated, and transformed. This literature review explores the impact of social media on religious belief, focusing on how these platforms influence religious practices and community formation.

Social media platforms have emerged as new arenas for religious expression and practice. Approximately 20 percent of adults in the US express their religious identity online, and nearly half of US adults frequently encounter religious content shared by others online [8]. Social media can exacerbate religious marginalization, as chat rooms and other platforms offer a venue for increased interreligious conflict and polarization [2, 24]. While religion can sometimes motivate social mobilization, it can also discourage collective action in different contexts [5].

In recent years, public conversation about how digital technology and social media are transforming religion has intensified [11]. Researchers have investigated mediatization, which refers to the long-term interactions between media and social and cultural transformations [14, 19, 20, 23, 27]. Mediatization explores the connection between media and enduring social and cultural processes, offering theoretical insights into the revival of religiously driven social and cultural transformations facilitated by new digital media while addressing the heightened visibility of religion in various public institutions [14, 27].

Previous research utilized the concept of "tinkering" to describe how younger generations perceive religion and how the emergence of internet technologies influences individuals to reconstruct their self-views [4, 33, 32]. Research indicates that the internet can serve as a tool for religious individuals and groups to "tinker" with traditional religious conceptions, offering a digital platform for greater religious inclusivity [21]. The rise in social media usage among religious individuals from various religious, racial, and ethnic backgrounds may enhance interactions across these boundaries, thereby reducing the likelihood of religious exclusivity [21].

Scholars of digital media and religion strive to differentiate between "religion online" and "online religion". They argue that "religion online" pertains to how traditional religious communities use the internet to perform functions such as reiterating faith identity and community outreach, extending activities of physical religious spaces into digital realms [6, 13]. Conversely, "online religion" involves religious and spiritual practices conducted via the internet itself [13]. These distinctions highlight how online community spaces can either supplement or substitute physical religious communities [6].

Religion manifests online primarily through static informational websites but also through interactive sites where congregants share religious capital and experiences [9]. Social media, in particular, provides a platform for observing spontaneous interactions among believers, as well as between believers and non-believers, free from the mediation of institutions such as mass media, religious leaders, or researchers [9].

One of the most significant impacts of social media on religious belief is its role in community formation. Social media allows for the creation of virtual religious communities that transcend geographic and cultural boundaries. Dangolla [10] explores how online communities facilitate the formation of new kinds of religious networks, which can be particularly important for diasporic populations. These virtual communities often provide support, foster a sense of belonging, and enable collective religious practices, even in the absence of a physical congregation.

The frequency and duration of access are key factors in social media usage and engagement although it is important to mention that digital media are always evolving, with the most popular forums, websites, and platforms constantly changing [16]. In our work, we address the frequency of social media engagement by quantifying two cases: Social media channels are the first places where the participants know about the TMT phenomenon and those are the main channels through which participants follow this phenomenon.

2.2 Social Media and Life Belief

Life beliefs, that encompass core values, worldviews, and philosophical stances, are increasingly influenced by social media in contemporary society. As a pervasive element of daily life, social media platforms have become spaces where life beliefs are expressed, contested, and reshaped. Social media plays a crucial role in shaping and reinforcing life beliefs by providing users with a continuous stream of content that aligns with their existing values and worldviews. According to Bakshy et al. (2015) [3], social media algorithms prioritize content that matches users' past behaviors and preferences, creating echo chambers where users are primarily exposed to beliefs that mirror their own. This selective exposure reinforces existing beliefs, making them more resilient to change [12].

In the context of forming new beliefs, Tufekci (2014) [31] examines how social movements leverage social media to disseminate ideological content and influence public opinion. Her research showed that social media platforms are effective tools for mobilizing support and spreading new beliefs, particularly among younger audiences. This capacity to rapidly disseminate ideas can lead to the formation of new life beliefs, as individuals are exposed to persuasive content that challenges or reshapes their existing worldviews.

2.3 Social Media and Life Motivation

Social media users have different life motivations [7]. There are a number of previous studies on the effects of social media on several kinds of motivation such as learning motivation [30], creative motivation [22], motivations for using social media [1], and intrinsic motivation [18].

Social media can have both positive and negative effects on life motivation, depending on how it is used and the nature of the content consumed. Social media platforms can provide access to motivational content, such as inspirational quotes, stories of personal growth, and achievements. Following positive role models or communities can encourage individuals to pursue their goals and maintain a positive outlook. Moreover, by connecting with others who share similar goals, interests, or values, social media users can feel a sense of belonging and purpose, which can reinforce their motivation to pursue specific life goals. On the negative side, the pressure to conform to societal standards, trends, or expectations on social media can create stress and anxiety, which may affect one's motivation to stay true to personal values or goals. Fear of judgment or criticism can also lead to a lack of motivation.

One main aspects of our work is quantifying the effects of social media on the motivation to practice the Five Precepts of Buddhism (abstaining from killing, stealing, sexual misconduct, lying, and intoxicants). To the best of our knowledge, our work is the first study exploring the effects of social media (YouTube, Tiktok, Facebook, etc) on the motivation to learn and practice the Five Precepts of Buddhism using causal machine learning. We observe that in the digital age, social media plays a significant role in shaping individuals' motivations and behaviors, including their adherence to these precepts.

3 Methods

There are two main approaches for causal inference: (1) Potential outcomes framework [25, 28] and (2) graphical causal models [26]. According to the potential outcomes framework, we only observe the outcome of either treatment or control group. This is the fundamental challenge in causal inference: the inability to observe both the potential outcomes of the same unit [15]. In this framework, the average treatment effect (ATE) is defined by the difference between the expected outcome of the treatment group and control group, i.e.

$$ATE := E[Y|T = 1] - E[Y|T = 0],$$

where T denotes the treatment and Y denotes the outcome. Empirically, researchers normally control for a number of confounding variables (or confounders) which the treatment and the outcome depend on. Taking into the confounding variables, the average treatment effect now becomes the conditional average treatment effect (CATE), which is defined as follows

$$CATE := E[Y|T = 1, X] - E[Y|T = 0, X],$$

where X is the list of confounders.

Based on the potential outcomes framework, we employ a wide range of methods for treatment effect estimation, including linear regression (LR), propensity score methods

(propensity score matching or PSM, propensity score stratification or PSS, distance matching or PSDM, and propensity score weighting or PSW), causal forests (CF), double machine learning (DML), and meta-learners (S-Learner, T-Learner, X-Learner, and R-Learner).

The second causal inference approach, graphical causal models, bases on directed acyclic graph (DAG). Typically, a DAG includes treatment, outcome, and a number of confounding variables (or confounders) which affect both the treatment and outcome. Note that, in the perspective of the graphical causal models, capturing confounders which only affect the treatment or only affect the outcome is not necessary. Figure 1 describes the causal graph of our work. In this graph, social media is the treatment, religious belief and life belief (or life perception) are the outcomes, and confounders are the list of confounding variables which affect both the treatment and the outcomes.
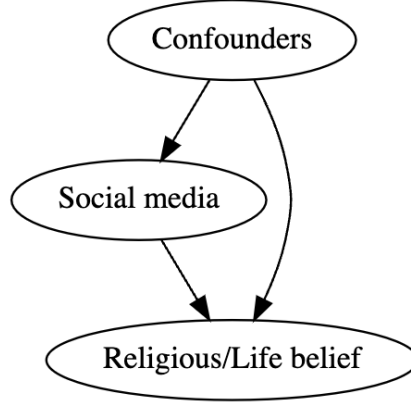

Figure 1: The causal graph

It is crucially important to note that we can claim causal effects with observational data by using (1) graphical causal models, (2) potential outcomes framework, and (3) current advanced causal machine learning methods. These causal effects are impossible before but feasible with the current advancements of causal inference and machine learning. First, graphical causal models restrict us to including only relevant confounders which can be obtained based on our domain knowledge. Second, potential outcomes framework allows us to separately work on the estimations for the treatment and control group. Third, recent studies in causal machine learning allow to directly employ machine learning models for the estimations of the treatment and control groups. At this point of time, lacking any of these three tools prevents us to claim causal effects with our observational data. Fortunately, we can claim causal effects by combining these three tools for our observational survey data. Note that current quasi-experimental methods such as difference-in-differences prevents us claiming causal effects of social media on various aspects of life using our observational survey data.

4   Data

4.1   Sample Collection

We collect the data from a survey using an online questionnaire. The respondents are Vietnamese who are currently living in Vietnam and foreign countries. The sample

collection procedure involves several steps. First, we design a questionnaire to measure the treatments, outcomes, and a list of confounders (Step 1). This questionnaire was sent to five experts in the field to ask for feedback (Step 2). The questionnaire was further improved based on their feedback (Step 3). We then did a pilot survey with a number of respondents (Step 4). We improved the questionnaire one more time based on the pilot survey (Step 5). Finally, we sent out the questionnaire to a large number of respondents via Facebook and email.

The final sample includes 1,885 observations. This final sample is obtained from the initial sample, which is nearly 2,000 observations. We excluded a number of observations due to incomplete responses. The data was collected in eleven days from May 28 to June 7, 2024. Table 1 presents the number of observations in our sample by country. Most respondents are from Vietnam. This makes sense since we target Vietnamese and most Vietnamese live in Vietnam. The runner-up group the United States of America (USA). This also makes sense since USA is the second-largest Vietnamese diaspora country. In total, the participants from 27 countries and territories joined our online survey.

Table 1: Number of observations by country

Country	n	Country	n
Vietnam	1,673	Singapore	2
USA	88	Poland	2
Australia	19	Europe	2
Japan	19	Belgium	2
Korea	14	Czech	2
Canada	10	Norway	2
Germany	10	UAE	1
UK	7	Thailand	1
Taiwan	7	Indonesia	1
France	6	Spain	1
Finland	5	Colombia	1
Italy	3	Malaysia	1
China	3	Laos	1
Netherlands	2	Total	1,885

4.2 Variables

Table 2 presents all variables and the corresponding definitions in the data set. For more details about measuring of all variables, please reference Appendix at the end of this paper. In this work, there are two treatments, i.e., social media being the first channel through which people get to know Thich Minh Tue phenomenon called Platform_Know, and social media being the main channel through which people follow Thich Minh Tue phenomenon called Platform_Follow and there are three outcomes, i.e., Belief_Buddhism, Belief_Life, and Motivation. Note that Platform_Know equals to 1 if the first platform to know about TMT phenomenon is social media (e.g. YouTube, TikTok, Facebook, etc) and 0 if otherwise (other channels of communication such as television, news, newspapers magazines, family, and friends). Similarly for the variable Platform_Follow.

Table 2: The variables and their definitions

Variable	Definition
Gender	Male (1), Female (0), Other (2), Not to answer (3)
Age	Age (in years)
Vietnam	Currently living in Vietnam (1), foreign (0)
Urban	Currently live living in urban area (1), rural (0)
Marriage	Marital status
Ethnicity	Ethnicity: Kinh (1), others (0)
Education	Educational attainment
Education (parents)	Educational attainment of parents
Income	Income range (in Vietnam Dong currency)
Job	Working industry
SM_Time	Number of hours using social media per day
Interested	Interested in social issues
Aware	Aware of the TMT phenomenon
Platform_Know	First platform to know about TMT phenomenon: Social media (1), Others (0)
Platform_Follow	Main platform to follow TMT phenomenon: Social media (1), Others (0)
HanhDauDa	A group of austerities or ascetic practices taught in Buddhism
TMT	Perception on TMT
TMT_Followers	Perception on TMT's followers
Belief_Buddhism	Change in belief in Buddhism after TMT phenomenon (5-point Likert scale)
Belief_Life	Change in life perception after TMT phenomenon (5-point Likert scale)
Motivation	Change in motivation to uphold five Precepts of Buddhism (5-point Likert scale)

4.3 Exploratory Data Analysis

Table 3 presents the descriptive statistics (mean, standard deviation, minimum, maximum, and 50% quantile or median) of all variables. Note that the minimum value of -1 in three variables, which are Education, EducationP, and Income, are the situations that the participants prefer not to answer.

Table 3: Descriptive statistics

	Mean	Std	Min	Median	Max
Gender	0.6259	0.5250	0	1	3
Age	38.9209	11.3948	17	38	99
Vietnam	0.8859	0.3179	0	1	1
Urban	0.9442	0.2294	0	1	1
Marriage	0.7878	0.6314	0	1	4
Ethnicity	0.9714	0.1669	0	1	1
Education	3.9406	1.1439	-1	4	5
EducationP	2.3841	1.7415	-1	2	5
Income	2.9846	1.8901	-1	3	5
Job	4.0504	3.0959	0	4	10
SM_Time	2.1682	0.6400	0	2	3
Interested	3.7199	1.0043	1	4	5
Aware	0.9671	0.1784	0	1	1
Platform_Know	2.0387	2.1328	0	1	10
Platform_Follow	2.3003	2.5470	0	1	11
HanhDauDa	1.2525	0.4798	0	1	2
TMT	1.8599	0.4849	0	2	2
TMT_Followers	1.1883	0.8094	0	1	2
Belief_Buddhism	2.5039	0.7202	0	3	3
Belief_Life	2.5819	0.6420	0	3	3
Motivation	2.5156	0.7303	0	3	3

We present here some striking statistics. We can observe that 88.59% respondents are currently living in Vietnam and 11.41% respondents are currently living in other countries. The mean age is around 39.92 with the youngest aged 17 and oldest aged 99. Interestingly, 94.42% respondents are currently living in urban areas and 5.58% living in rural areas. Regarding ethnicity, 97.14% of respondents are the Kinh people and the rest are other ethnicities. This makes sense since about 87% of Vietnamese are the Kinh people[2], and they tend to live in urban areas with with easier and better access to the internet and social media than most other ethnicities. Another interesting point is that, on average, respondents have higher educational attainment than their parents.

5 Results

We will explore separately the the social media platforms as the *first* channels that the participants know about the TMT phenomenon and those *main* channels that the participants use to follow the TMT phenomenon after knowing about this phenomenon. There are two situations (the first vs. main channels) and three outcomes (Buddhism belief, life belief, and life motivation). In total, there are six cases that we quantify eventually in the following subsections.

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[2]See https://vietnamembassy-usa.org/culture/ethnic-groups.

5.1 Causal Effect of (First) Social Media on Buddhism Belief

Table 4 shows the average treatment effect (ATE) estimation and confidence interval (CI) each method. It can be seen that in all cases, the ATEs are consistently positive. This implies that social media, as the first channel so that the respondents know about the TMT phenomenon, has a positive effect on the belief in Buddhism in comparison to other communication channels such as television, online news, and friends and family. Note that the abbreviations in Table 4 are: LR, Linear Regression; PSM, Propensity Score Matching; PSS, Propensity Score Stratification; PSDM, Propensity Score Distance Matching; PSW, Propensity Score Weighting; DML, Double/Debiased Machine Learning; CF, Causal Forests.

Table 4: Causal effect estimations of social media on Buddhism belief

Method	ATE	CI
LR	0.1141	[0.0345, 0.1936]
PSM	0.0419	[-0.0467, 0.1135]
PSS	0.0989	[-0.0089, 0.2134]
PSDM	0.0833	[-0.0069, 0.1708]
PSW	0.0908	[-0.0035, 0.1782]
DML	0.0995	[0.0171, 0.1818]
CF	0.1107	[-0.0475, 0.269]
S-Learner	0.0843	[0.0617, 0.1068]
T-Learner	0.0675	[0.0445, 0.0905]
X-Learner	0.0666	[0.0489, 0.0842]
R-Learner	0.1229	[0.1209, 0.1249]

Table 5 presents the ATEs using different meta-learners with different supervised machine learning models. It is obvious that all ATEs in all cases in this table are consistently positive, which implies the robustness of our treatment effect estimations. Note that the abbreviations in Table 5 are: DT, Decision Trees; RF, Random Forests; LGBM, Light Gradient Boosting Machine; XGB, eXtreme Gradient Boosting.

Table 5: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.0398	0.0619	0.0759	0.0843
T-Learner	0.1125	0.0769	0.0677	0.0675
X-Learner	0.0002	0.0758	0.0741	0.0666
R-Learner	0.4087	0.3269	0.0871	0.1229

In order to check further robustness of our treatment effect estimations, we carry out several refute tests, including placebo test and several data subset (Subset for short) refuters. We summarize all the refute tests in Table 6. For placebo refuter, we randomly replace our treatment (Platform_Know) by a random variable, which is generated by a widely used library for treatment effect estimation using observational data: DoWhy [29]. As a result, the new effect is dropped significantly compared to the estimated (Est for short) effect. For subset refuters, we randomly choose 20%, 50%, 70%, and 90% of the data and then run the treatment effect estimations on these

subsets of data to see where the new effects from these subsets of data are close to those from the entire data or not. It can be seen that the new effects (New effect) are relatively close to the estimated effect (Est effect). Especially, when we randomly use 90% of the data, both the new effect and estimated effect are almost the same, which are 0.1142 and 0.1141.

Table 6: Refute tests for models using linear regression

Refuter	Est effect	New effect
Placebo refuter	0.1141	0.0113
Subset refuter (20%)	0.1141	0.1094
Subset refuter (50%)	0.1141	0.1044
Subset refuter (70%)	0.1141	0.1312
Subset refuter (90%)	0.1141	0.1142

5.2 Causal Effect of (First) Social Media on Life Belief

Table 7 presents the average treatment effect estimations and their corresponding confidence intervals of models using all given causal methods. It can be seen that all treatment effect estimations are consistent in direction. Moreover, their magnitudes are relatively similar.

Table 7: Causal effect estimations of social media on life perception

Method	ATE	CI
LR	0.1034	[0.0262, 0.1806]
PSM	0.0976	[-0.0286, 0.1958]
PSS	0.0961	[0.0146, 0.2359]
PSDM	0.0976	[0.0074, 0.1862]
PSW	0.0989	[-0.0102, 0.1879]
DML	0.1478	[0.0596, 0.2360]
CF	0.1562	[-0.0008, 0.3132]
S-Learner	0.0679	[0.0476, 0.0882]
T-Learner	0.0958	[0.0732, 0.1184]
X-Learner	0.0785	[0.0604, 0.0965]
R-Learner	0.0758	[0.0737, 0.0779]

A striking result in Table 8 is that all ATEs are positive. Also, all ATEs are not much different except for two ATEs for estimations using R-Learner and decision tree regressor and random forest regressor.

Table 8: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.0578	0.0719	0.0839	0.0679
T-Learner	0.1263	0.1038	0.0820	0.0958
X-Learner	0.0980	0.0927	0.0804	0.0785
R-Learner	0.6260	0.4199	0.0043	0.0758

We also carry out some the placebo refute test and some subset refute tests. The main results are similar as those in Table 6: the new effect in the placebo test is around zero, and the new effects and estimated effects are similar across all subset refutation tests. To avoid unnecessary redundancy, we do not present the detailed results in this and subsequent cases.

5.3   Causal Effect of (First) Social Media on Life Motivation

Table 9 presents the average treatment effect estimations of the social media, as the first place that participants know about the TMT phenomenon, on life motivation. Most ATEs range between 0.06 and 0.1 and they are all consistently positive. Most lower and upper bounds of the confidence intervals have the same side (i.e., positive). In case the lower bounds are negative, their magnitudes are very close to zero. These imply that our causal effect estimations are reliable.

Table 9: Causal effect estimations of social media on motivation

Method	ATE	CI
LR	0.0985	[0.0213, 0.1757]
PSM	0.0748	[-0.0149, 0.1708]
PSS	0.1051	[0.0019, 0.2222]
PSDM	0.0673	[-0.0069, 0.1549]
PSW	0.0844	[-0.0227, 0.1816]
DML	0.0822	[0.0015, 0.1629]
CF	0.0851	[-0.0685, 0.2388]
S-Learner	0.0617	[0.0428, 0.0805]
T-Learner	0.0769	[0.0539, 0.0997]
X-Learner	0.0482	[0.0306, 0.0659]
R-Learner	0.0392	[0.0372, 0.0412]

All ATEs in Table 10 are also positive and the estimated values are not much different except for the case of R-Learner using decision tree or random forest regressor.

Table 10: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.0775	0.0558	0.0649	0.0617
T-Learner	0.0822	0.0936	0.0874	0.0769
X-Learner	0.0846	0.0621	0.0841	0.0482
R-Learner	0.2203	0.2611	0.1269	0.0392

5.4   Causal Effect of (Main) Social Media on Buddhism Belief

Table 11 presents the average treatment effect estimations of social media, as the main channel to follow TMT phenomenon, on Buddhism belief. It is obvious that all ATEs are consistently positive and they are all statistically significant at the significance level of 5%. Not only consistency in sign, all ATEs are also of relatively consistent magnitude. Also, the lower and upper bounds of all confidence intervals are positive

and the ranges of all confidence intervals are relatively narrow, which indicate that our estimations are precise and reliable.

Table 11: Causal effect estimations of social media on Buddhism belief

Method	ATE	CI
LR	0.3424	[0.2695, 0.4153]
PSM	0.3958	[0.3056, 0.5369]
PSS	0.3303	[0.2515, 0.4103]
PSDM	0.3459	[0.2525, 0.3989]
PSW	0.3713	[0.2838, 0.4452]
DML	0.3256	[0.2432, 0.4081]
CF	0.3324	[0.1977, 0.4671]
S-Learner	0.2772	[0.2568, 0.2977]
T-Learner	0.2798	[0.2559, 0.3037]
X-Learner	0.2721	[0.2536, 0.2907]
R-Learner	0.3001	[0.2983, 0.3019]

In the models using meta-learners in Table 11 above, we used XGBoost regressor for estimations. However, in principle, one can use any supervised machine learning methods for meta-learners. We go ahead to perform meta-learners with three more additional regressors including decision trees, random forests, and Light GBM. Table 12 shows the ATEs of models using meta-learners with different supervised machine learning models.

Table 12: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.2438	0.2993	0.3232	0.2772
T-Learner	0.2512	0.2966	0.3032	0.2798
X-Learner	0.2203	0.2729	0.3034	0.2721
R-Learner	0.6997	0.6028	0.2417	0.3001

In order to check the robustness of our estimations, we carry out some refute tests for the estimation using linear regression (the benchmark method), including placebo test and some data subset refute tests. The results show that the magnitude of the new effect is around zero, which significantly decreases from that of estimated effect (0.3424). Also, all of the new effects converge to the estimated effect for all subset refute tests.

Table 13: Refute tests for models using linear regression

Refuter	Est effect	New effect
Placebo refuter	0.3424	0.0178
Subset refuter (20%)	0.3424	0.3205
Subset refuter (50%)	0.3424	0.3517
Subset refuter (70%)	0.3424	0.3489
Subset refuter (90%)	0.3424	0.3432

5.5 Causal Effect of (Main) Social Media on Life Belief

Table 14 presents the average treatment effect estimations of social media, as the main channel to follow the TMT phenomenon, on the life belief. It is obvious that all ATEs are positive and very similar in terms of magnitude (more or less around 0.3).

Table 14: Causal effect estimations of social media on life perception

Method	ATE	CI
LR	0.3311	[0.2604, 0.4019]
PSM	0.3714	[0.2844, 0.5003]
PSS	0.3108	[0.2155, 0.4044]
PSDM	0.3332	[0.2446, 0.4053]
PSW	0.3551	[0.2711, 0.4399]
DML	0.3248	[0.2418, 0.4077]
CF	0.3301	[0.1863, 0.4740]
S-Learner	0.3004	[0.2799, 0.3208]
T-Learner	0.2861	[0.2642, 0.3080]
X-Learner	0.2792	[0.2624, 0.2960]
R-Learner	0.3043	[0.3025, 0.3062]

Table 15 shows that all ATEs of models using meta-learners with different supervised machine learning models are somehow similar. Two exceptions are the ATEs for the case of R-Learner using decision trees and random forests. These two ATEs are more significant than the other ATEs. However, in terms of sign, they are all positive.

Table 15: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.2992	0.2982	0.3165	0.3004
T-Learner	0.2875	0.3095	0.3134	0.2861
X-Learner	0.2647	0.2891	0.3188	0.2792
R-Learner	0.8108	0.6619	0.2205	0.3043

5.6 Causal Effect of (Main) Social Media on Life Motivation

The average treatment effect estimations of models using all given methods are shown in Table 16. All results in this table are very good as the ATEs are stable (around 0.3). Also, the confidence intervals are relatively narrow.

Table 16: Causal effect estimations of social media on motivation

Method	ATE	CI
LR	0.3259	[0.2551, 0.3966]
PSM	0.3915	[0.3103, 0.5247]
PSS	0.3291	[0.2455, 0.4124]
PSDM	0.3241	[0.2345, 0.3989]
PSW	0.3587	[0.2758, 0.4338]
DML	0.3303	[0.2540, 0.4067]
CF	0.2955	[0.1584, 0.4327]
S-Learner	0.3122	[0.2930, 0.3314]
T-Learner	0.2898	[0.2669, 0.3128]
X-Learner	0.3113	[0.2931, 0.3296]
R-Learner	0.2986	[0.2968, 0.3005]

Table 17: Meta-learners with different supervised ML models

	DT	RF	LGBM	XGB
S-Learner	0.2554	0.2998	0.3318	0.3122
T-Learner	0.3167	0.2995	0.2924	0.2898
X-Learner	0.3966	0.2736	0.3042	0.3113
R-Learner	0.5998	0.6310	0.2581	0.2986

6   Discussion and Conclusion

With two treatments (Platform_Know and Platform_Follow) and three outcomes (Buddhism belief, life perception, and life motivation), this work quantifies six causal relationships corresponding to six pairs of variables. The detailed results of all six cases are presented in Results section. In general, the magnitudes of causal effects of social media as the *main* platforms to follow the TMT phenomenon on Buddhism belief (Table 11), life perception (Table 14), and motivation of life (Table 16) are remarkably greater than those of social media as the *first* platform that people know about the phenomenon (Table 4, Table 7, and Table 9, respectively). This result makes sense as it is reasonable that the social media channels as the main platforms are usually used many times, which cumulatively should have stronger impacts than a social media channel which is used only one time but then the audience switch on the other communication channels.

A noticeable point is that all of the causal effect estimations of both *first* and *main* social media platforms are consistent in terms of sign, magnitude, and precision (i.e. small arrow of confidence intervals). This implies that our causal estimations are reliable in all cases. In addition, our causal estimations are not only consistent but also robust under several refute tests. Note that we view the TMT phenomenon in our work as a case study. That means the approaches and methods in our work can be employed to explore the causal effect of social media's influence, as communication channels, on the consequences of the social, cultural, and religious phenomena/events.

In conclusion, our work quantifies the role of social media in the recent viral of the TMT phenomenon in Vietnam. By conducting an online survey to obtain obser-

vational data, we employ some advanced causal machine learning methods to detect the causal relationships between social media and religious belief, life perception, and motivation. We find that social media has a special role compared to other traditional communication channels regarding religious and life beliefs through a case study of the TMT phenomenon. Specifically, all treatment effect estimations are positive which indicate that the causal effects of social media on Buddhism belief, life perception, and motivation are stronger than through any other communication channels such as television, news, family, and friends.

Theoretically, we contribute to the causal understanding on the effects of social media on non-business context especially religion, life perception, and people's motivation to practice some five good precepts in Buddhism (and also in normal life): not killing, not stealing, not misusing sex, not engaging in false speech, and not indulging in intoxicants. This case study can be applied to many other non-business issues in our society, which outnumber business-related issues. This implies the power of social media on all aspects of life in modern society.

Practically, the procedure and methods used in our work can be applied to study other phenomena/events in information systems (e.g. the emergence of ChatGPT) and beyond (Taylor Swift with the Era Tour or Greta Thunberg for calling on world leaders to quickly tackle and mitigate the effects of climate change resulting from human activities).

Acknowledgement

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Appendix: Questionnaire and Encoding

Hello, we are a research team from Michigan State University and colleagues. We are surveying the role of social media in religion, life perception, and life motivation through the TMT phenomenon. Survey information is collected anonymously and used solely for research purposes. We appreciate your time participating in our survey.

The survey questions and their corresponding encoded levels are detailed below:

1. What is your gender?

   - Male: 1
   - Female: 0
   - Non-binary: 2

- Prefer not to answer: 3

2. What is your age?

3. What is the country that you are living in right now?

4. Are you living in urban or rural area?

   - Urban: 1
   - Rural: 0

5. What is your marital status?

   - Not Yet Married: 0
   - Married: 1
   - Divorced: 2
   - Widowed: 3
   - Others: 4

6. What is your ethnicity?

   - Kinh: 0
   - Others: 1

7. What is your religion?

   - Atheism: 0
   - Buddhism: 1
   - Catholicism: 2
   - Protestantism: 3
   - Hoahaoism: 4
   - Caodaism: 5
   - Others: 6

8. What are the religion(s) of your parents?

   - Atheism: 0
   - Buddhism: 1
   - Catholicism: 2
   - Protestantism: 3
   - Hoahaoism: 4
   - Caodaism: 5
   - Others: 6

9. What is your highest level of education?

   - Primary School: 0

- Secondary School: 1
- High School: 2
- Vocational School: 3
- Bachelor's Degree: 4
- Graduate Degree: 5
- Prefer not to answer: -1

10. What are the highest level of education of your parents?

- Primary School: 0
- Secondary School: 1
- High School: 2
- Vocational School: 3
- Bachelor's Degree: 4
- Graduate Degree: 5
- Prefer not to answer: -1

11. What are your income range?

- No income: 0
- Less than 5 million VND per month: 1
- 5-10 million VND per month: 2
- 10-20 million VND per month: 3
- 20-30 million VND per month: 4
- Over 30 million VND per month: 5
- Prefer not to answer: -1

12. Which industry that are you working right now?

- Student: 0
- Education and Research: 1
- Technology and Manufacturing: 2
- Healthcare: 3
- Business and Retail: 4
- Hospitality and Service Providers: 5
- Religion: 6
- Governance: 7
- National Defense: 8
- Stay-at-Home Parent: 9
- Others: 10

13. What is your average daily social media usage?

- None: 0
- Less than 1 hour: 1
- From 1-3 hours: 2
- Over 3 hours: 3

14. On a scale of 1 to 5, how much importance do you place on and follow current social trends and phenomena?

15. Are you aware of the TMT phenomenon?

- No: 0
- Yes: 1

16. What is the first platform where you learned about the TMT phenomenon?

- NA: 0
- Facebook: 1
- Youtube: 2
- Zalo: 3
- TikTok: 4
- Instagram: 5
- X: 6
- Broadcast Source: 7
- Online Newspaper: 8
- Friends and Family: 10
- Other: 11

17. Where do you primarily get updates on the TMT phenomenon?

- NA: 0
- Facebook: 1
- Youtube: 2
- Zalo: 3
- TikTok: 4
- Instagram: 5
- X: 6
- Broadcast Source: 7
- Online Newspaper: 8
- Friends and Family: 10
- Other: 11
- No further update: 12

18. Are you aware of the presence of the monk named Hanh Dau Da?

- NA: 0
- No: 1
- Yes: 2

19. What is your perception of Thich Minh Tue?

    - NA: 0
    - Negative: 1
    - Positive: 2

20. What is your perception of the monks following Thich Minh Tue?

    - NA: 0
    - Negative: 1
    - Positive: 2

21. How does the TMT phenomenon impact your belief in Buddhism?

    - NA: 0
    - Decreased: 1
    - Unchanged: 2
    - Increased: 3

22. How does the TMT phenomenon affect your positive outlook on life?

    - NA: 0
    - Decreased: 1
    - Unchanged: 2
    - Increased: 3

23. How does the Thich Minh Tue phenomenon affect your motivation to uphold the Five Precepts of Buddhism?

    - NA: 0
    - Decreased: 1
    - Unchanged: 2
    - Increased: 3