

How did Internet usage affect life satisfaction before and after COVID-19? Mediating effects and heterogeneity analysis

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ARTICLE INFO

Keywords:

Internet usage
Life satisfaction
Mediating mechanism
Heterogeneity analysis
COVID-19 pandemic

ABSTRACT

Digitalization has profoundly reshaped work modes and lifestyles and impacted individuals' life satisfaction. However, there has been limited research exploring this issue while comparing the effects before and during the COVID-19 pandemic. Furthermore, investigating heterogeneity across different socio-economic groups is crucial. This study uses data from the latest three waves of the European Social Survey in 2016, 2018, and 2020 to examine the influence of Internet usage on life satisfaction, unravel its underlying mechanisms, and conduct heterogeneity analysis with the fixed-effects ordered logit model and propensity score matching method. The empirical findings reveal the following: (a) Internet usage has significant and positive effects on life satisfaction, although the marginal effects of Internet usage decreases as respondents' life satisfaction increases; (b) respondents with a "right" political tendency, higher levels of social interaction and trust, females, older individuals, higher income earners, those with lower education levels, better health conditions, and stronger religious beliefs tend to report higher life satisfaction; (c) work flexibility, work-life balance, and team engagement are identified as essential mediating factors in the relationship between Internet usage and life satisfaction; (d) Internet usage has had a significant and positive effect on life satisfaction since the outbreak of the COVID-19 pandemic, whereas this was not the case before the pandemic; and (e) the influence of Internet usage on life satisfaction is more pronounced among young, affluent communities, well-educated individuals, Eastern and Central Europeans, non-managers, and employees of central/local governments and private firms. This study underscores the rapid socio-economic transformation induced by digitalization in Europe and provides valuable insights on leveraging the Internet to improve individual life satisfaction in the post-pandemic era.

1. Introduction

The development of information and communication technology (ICT) has dramatically transformed both work and lifestyle [1]. The widespread use of network terminal applications has significantly increased Internet usage frequency [2]. As of early 2023, there are 5.16 billion Internet users worldwide, accounting for 64.4 percent of the global population [3]. Internet usage has not only brought about convenience [4] but also enriched the diversity of work and life experiences [5]. At the same time, the increased Internet usage frequency has driven the renewal and iteration of ICT and incentivized Internet businesses to continuously develop new application scenarios and improve user experiences. The outbreak of the COVID-19 pandemic further highlights the advantages of online networking over offline activities [6]. Pandemic-related measures mandated residents to stay at home, leading

to the development of online telecommuting activities and transforming various aspects of work and lifestyle. This ongoing socio-economic transformation in the digital era has been accelerated by the pandemic, leading to variations in the public's life satisfaction [7]. However, it remains unclear whether and how such digitalization affects life satisfaction within the European context.

Life satisfaction has long been a focus of study in psychology and economics, and its determinants have been central to the field of happiness economics since the formation of the "Easterling Paradox" [8]. Campbell [9] was the first to define life satisfaction as people's assessment of how content they are with their living conditions, based on their own values criteria and subjective preferences. Subsequently, researchers have made considerable efforts to explore the determinants of life satisfaction, summarizing factors that influence it, including the external environment [10], social status [11], job satisfaction [12],

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<https://doi.org/10.1016/j.seps.2024.102007>

Received 8 August 2023; Received in revised form 11 June 2024; Accepted 25 June 2024

Available online 29 June 2024

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work–life balance [13], and individual characteristics such as income, health status, and education [14]. These endeavors have laid a solid theoretical foundation for the academic community.

With the development of digitalization, the impact of Internet usage on life satisfaction has garnered significant attention in academia in recent years [15–17]. Early studies primarily focused on examining the relationship between Internet usage and individual welfare, particularly the influence on social participation and mental health [18]. Economists, using individual-level survey data, have quantitatively analyzed the nexus between Internet usage and life satisfaction, including both positive and negative effects. The positive impact of Internet usage on life satisfaction is mainly observed through enhanced social interaction [19], increased consumption of leisure and entertainment [20], improved work productivity [21], and the provision of online public services [22]. Conversely, negative effects are attributed to an increase in material desires [23], a higher likelihood of comparing oneself with higher income groups [24], and an augmented perception of environmental pollution [25].

Despite the research mentioned above, to the best of our knowledge, no studies have compared the impact of Internet usage on life satisfaction before and during COVID-19 or explored the influencing mechanisms. Most related studies focus on the period before the pandemic or only concentrate on the pandemic period without offering a comparative analysis or exploring the mechanism test. Furthermore, a comprehensive and systematic heterogeneity analysis among multiple socio-economic groups remains unaddressed. In light of these research gaps, this study aims to systematically examine the impact of Internet usage on life satisfaction, its effects before and during COVID-19, the influencing mechanisms, and heterogeneity analysis. To this end, the study uses the latest European Social Survey (ESS) data from 2016, 2018, and 2020 while applying the fixed-effects ordered logit model, the propensity score matching (PSM) method and instrumental variable estimation. Two key contributions are made. First, this study uses the most recent three waves of ESS data to compare the impact of Internet usage impact on life satisfaction before and during COVID-19. It is the first to explore its influencing mechanisms and conduct heterogeneity analysis across multiple socio-economic groups (e.g., age, income, education, region, occupation) in Europe. The findings contribute to enriching the research theories in this field. Second, by employing the fixed-effects ordered logit model, the PSM method, and instrumental variable estimation, the study reduces data bias and mitigates the issue of endogeneity, which arises from dual causality [26], thus resulting in more robust and reliable empirical results.

The remainder of the paper is structured as follows. Section 2 provides a comprehensive review of related literature, clarifying the mechanisms through which Internet usage impacts life satisfaction and presenting corresponding hypotheses. In Section 3, we discuss the data and empirical strategies, which encompass an introduction to the database, descriptive statistics of the relevant data, and the formulation of empirical models. Empirical results are presented in Section 4. Section 5 discusses and Section 6 concludes the paper with policy recommendations based on the findings.

2. Literature review and hypotheses

2.1. The impact of internet usage on life satisfaction

With the rapid development of digitalization, a substantial body of literature has emerged exploring the relationship between Internet usage and life satisfaction. On the one hand, numerous researchers argue that Internet usage has a positive impact on life satisfaction by influencing time allocation, innovating activities, integrating information, and improving communication efficiency [27]. Moreover, Internet usage has been associated with improved physical, mental, social health [28,29], as well as an expansion of leisure activities [30] and online credit creation [31], all of which positively correlates with life

satisfaction. Empirical studies have consistently confirmed this positive effect. For instance, Lu and Kandilov [32] found that individuals using mobile Internet report approximately 0.4 points higher life satisfaction than their non-user counterparts, Zhong et al. [33] reported a slightly lower positive effect of 0.3 points. However, alongside the evidence supporting a positive effect, there are also empirical results indicating a negative effect of Internet usage on life satisfaction. Zhang et al. [25] found that Internet users are less satisfied with their living conditions than non-Internet users. Nevertheless, arguments about the negative impact have mainly centered around issues of overuse or psychological changes observed in certain groups, such as adolescents [34] and low-income earners [24].

On the other hand, in line with revealed preference theory [35], it is posited that the positive utility brought by Internet usage to individuals drives the emergence of various Internet application scenarios, such as “Internet plus medical treatment” [22], “Internet plus tourism” [36], “Internet plus education” [37], etc. Without this positive utility, the Internet would struggle to gain sufficient market demand to support its development. Consequently, according to revealed preferences, the utility generated by Internet usage for individuals in society is positive. Importantly, utility in economics constitutes a key source of life satisfaction in sociology [38], thereby supporting the formulation of Hypothesis 1.

H1. Internet usage significantly and positively affects life satisfaction.

2.2. The nexus between internet usage and life satisfaction before and during COVID-19

The outbreak of the COVID-19 pandemic and the subsequent social distancing and lockdown measures had a profound impact on society, leading to a surge in online activities for both work and daily life [39, 40]. Previous research in this area has mainly focused on pandemic-induced Internet addiction and its effect on happiness and satisfaction [41]. Thompson et al. [42] identify the fear of COVID-19 as a powerful factor linked to emotional health, showing positive associations with psychological distress, depression, anxiety, and lower life satisfaction. As a result, Mahamid et al. [43] calls for intervention programs directed at decreasing Internet usage to better address the issues of “necessary” excessive usage during COVID-19 restrictions. However, there is limited evidence comparing the effects before and during COVID-19.

During the COVID-19 pandemic, the role of the Internet in alleviating people’s anxiety and feelings of helplessness became more pronounced than before, addressing both psychological and work-related aspects. Focusing on the Sweden population, Ekstrand et al. [44] pointed out that the negative impact of COVID-19 on life satisfaction stems from the disruption of human networks, leading to psychological stress and increased mental strain at work. Internet usage has been shown to bridge the social gap among the general population [28]. With offline social communication restricted, online communication serves to lessen people’s feelings of loneliness [45]. In addition to psychological support, Internet usage can also provide more convenience for people to work, including job searching [46] and remote work [47], which can provide income to support basic living needs during the pandemic. Without these online opportunities, people are more susceptible to financial hardship due to the loss of offline employment during COVID-19.

While Taskin and Ok [48] revealed a strengthened negative impact of problematic smartphone usage on life satisfaction in the post-pandemic period compared with the pre-pandemic period in South Korea, their sample was limited to a specific sector and may not capture the broader picture. Therefore, it is essential to conduct a comprehensive comparison of the effect of Internet usage on life satisfaction before and during the pandemic to gauge the extent to which COVID-19 accelerated the digitalization process and its impact on individuals’ satisfaction with life. Considering the widely recognized rapid digital

transformation after the pandemic, we propose the following Hypothesis 2.

H2. The relationship between Internet usage and life satisfaction is more significant during COVID-19 than before.

2.3. *The mediating effect of work flexibility, work–life balance, and team engagement*

There is ample evidence supporting the notion that Internet usage improves work flexibility [49–51]. Various office and conference software applications enable individuals to telecommute from home [52] or shared workspace [53], eliminating the need to be physically present at the workplace for tasks such as online sales and virtual meetings. Therefore, Internet usage enhances workers' autonomy to decide when and where to work, thereby increasing work flexibility [54]. Employees benefit from the flexibility to choose their work time and location, leading to an improvement in work equity [52]. Previous research views this change positively [55], thus contributing to an improvement in life satisfaction. Based on this, Hypothesis 3a is proposed.

Furthermore, Internet usage also contributes to promoting work–life balance [56], a factor closely associated with higher life satisfaction [57]. On the one hand, Internet usage effectively enhances work efficiency, resulting in more benefits for employees, such as increased motivation and productivity and reduced pressure [58]. These benefits contribute to a more balanced integration between work and personal life. On the other hand, the widespread use of mobile phones and ICT development facilitates cross-space communication, reducing employees' commuting time and increases leisure time [30]. As a result, work–life balance is promoted [59], which supports Hypothesis 3b.

In addition, Internet usage can enhance life satisfaction by promoting team engagement. As a new means of interpersonal communication and socialization, the positive impact of the Internet on social participation has been confirmed by numerous studies [60,61]. The online communication function of the Internet enables people to maintain timely communication within work teams and community groups and increases the frequency of communication, which enhances the sense of team engagement and self-esteem [62]. This, in turn, reduces feelings of loneliness and depression, effectively improving people's mental health and life satisfaction [63]. Accordingly, Hypothesis 3c is proposed.

H3a. Internet usage positively affects life satisfaction by improving work flexibility.

H3b. Internet usage positively affects life satisfaction by promoting work–life balance.

H3c. Internet usage positively affects life satisfaction by enhancing team engagement.

2.4. *Heterogeneity analyses for multiple socio-economic groups*

While Internet usage contributes to improving life satisfaction, as discussed above, the positive effects vary across socio-economic groups. These effects are influenced by various factors, such as the living environment [64], individual characteristics [27], and the purpose and manner of Internet usage [65], all of which contribute to heterogeneity in outcomes. Specifically, these factors include age, income, education, region, occupation, etc.

Lissitsa and Chachashvili-Bolotin [66] have highlighted that the elderly mainly use the Internet for health management [67], maintaining and expanding their social networks [68,69], and pursuing leisure activities in their old age [70]. Younger individuals, on the other hand, also use the Internet for improved work convenience, which is less relevant to the elderly, leading to a more diverse usage of the Internet than among the elderly [50]. In addition, the gradual decline in health status with age can result in a reduced perception of life satisfaction among the elderly [71]. As a result, the positive effect of Internet usage

on life satisfaction decreases with age, supporting Hypothesis 4a.

Existing literature indicates that individuals with higher incomes generally report higher life satisfaction [72,73]. As Internet usage becomes more widespread, people are more likely to engage in online comparisons, as mentioned in Section 2.1. Those with higher incomes are more likely to experience satisfaction in such comparisons, whereas those with lower incomes may perceive a decrease in satisfaction [74]. Therefore, Hypothesis 4b is proposed. Furthermore, considering the uneven economic development among European countries [75], it can be inferred that regions with higher per capita income experience greater satisfaction from Internet usage than regions with lower per capita income, supporting Hypothesis 4c.

Education levels also influence life satisfaction. Scholars have explored the relationship between educational level and life satisfaction mainly from the perspectives of income [76] and non-monetary factors [77]. Higher education is often associated with higher income, which is conducive to life satisfaction [78]. Moreover, in terms of non-monetary factors, individuals with a higher level of education are more likely to have strong social networks and cosmopolitan experiences, which can further improve life satisfaction [77]. Therefore, Hypothesis 4d is proposed.

Work status is a key mechanism through which Internet usage affects life satisfaction [79], and occupation is a primary determinant of work status, constituting another source of heterogeneity. On the one hand, the type of occupation is closely related to income [80], and individuals with higher incomes are more likely to derive greater satisfaction from Internet usage. On the other hand, occupational status often implies social status [81], and individuals with higher social status are more likely to experience higher fulfillment in the network. As a result, we propose Hypothesis 4e.

H4a. Younger age is associated with a higher likelihood of experiencing a positive effect of Internet usage on life satisfaction.

H4b. Higher-income groups are more likely to experience a positive effect of Internet usage on life satisfaction.

H4c. The positive effect of Internet usage on life satisfaction is more significant in regions with higher economic development than in regions with lower economic development.

H4d. The positive effect of Internet usage on life satisfaction increases with the level of education.

H4e. Occupations with higher income and status are more likely to derive satisfaction from Internet usage.

Based on the discussions above, this study systematically examines the impact of Internet usage on life satisfaction and proposes relevant hypotheses. The research framework is illustrated in Fig. 1.

3. Data and method

3.1. *Data*

The dataset used in this study was obtained from the ESS, a biennial survey conducted by the European Research Infrastructure. The ESS aims to measure changes over time in living conditions, social structures, public opinion, and attitudes within and between European countries while promoting the highest scientific standards in cross-country comparative research in the social sciences. To this end, it has conducted 10 rounds of surveys so far, with new respondents selected for each round through face-to-face interviews with residents in more than 30 European countries. To ensure data reliability and reduce the margin of error, each country participating in the ESS survey must achieve a minimum effective sample size of 1,500, which is reduced to 800 for smaller countries (those with fewer than 2 million people).

In this study, we estimate the relationship between Internet usage and life satisfaction by using the latest three waves of the ESS, namely

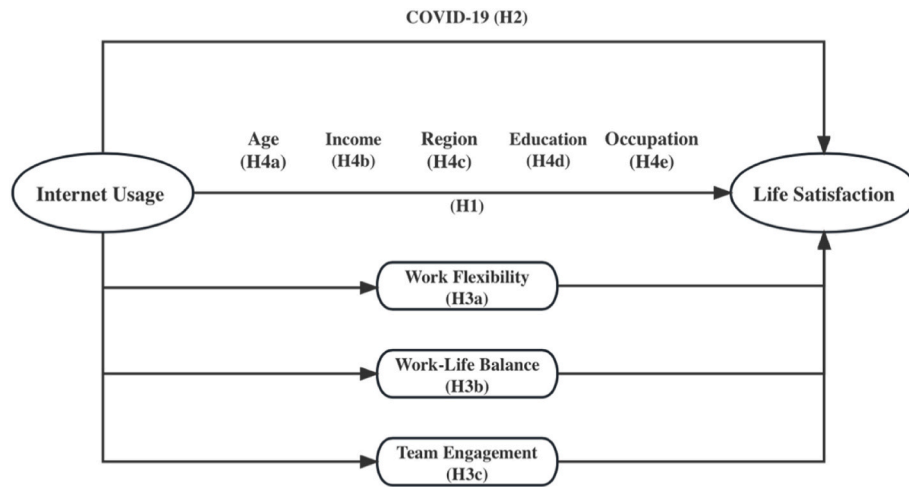


Fig. 1. Research framework.

Table 1
Descriptive statistics.

Variable	Question in the ESS questionnaire	Responses	Observations	Mean
<i>Dependent Variable</i>				
<i>Life Satisfaction</i>	B27: All things considered, how satisfied are you with your life as a whole nowadays?	Responses are expressed on an 11-point scale ranging from 0 ("Extremely dissatisfied") to 10 ("Extremely satisfied").	107,488	7.17
<i>Mediating Variables</i>				
<i>Work Flexibility</i>	F27: Please say how much the management at your work allows you to decide how your own daily work is organized?	Responses are expressed on an 11-point scale ranging from 0 ("I have no influence") to 10 ("I have complete control").	100,449	6.41
<i>Work-Life Balance</i>	G35: How often do you feel too tired after work to enjoy the things you would like to do at home?	1 = "Never," 2 = "Hardly ever," 3 = "Sometimes," 4 = "Often," 5 = "Always."	23,738	3.06
<i>Team Engagement</i>	G51: How much do you feel like part of your team?	Responses are expressed on an 11-point scale ranging from 0 ("Not at all") to 10 ("Completely").	12,046	8.39
<i>Independent Variables</i>				
<i>Internet Usage</i>	A2: How often do you use the Internet on these or any other devices, whether for work or personal use?	1 = "never," 2 = "only occasionally," 3 = "a few times a week," 4 = "most days," 5 = "every day."	107,488	4.07
<i>Political Orientation</i>				
<i>Political Interest</i>	B1: How interested would you say you are in politics?	1 = "very interested," 2 = "quite interested," 3 = "hardly interested," 4 = "not at all interested."	107,488	2.50
<i>Political Tendency</i>	B26: In politics, people sometimes talk of 'left' and 'right.' Where would you place yourself on this scale?	Responses are expressed on an 11-point scale ranging from 0 (Left) to 10 (Right).	107,488	5.03
<i>Social Engagement</i>				
<i>Social Interaction</i>	C2: How often do you meet socially with friends, relatives, or work colleagues?	1 = "Never," 2 = "Less than once a month," 3 = "Once a month," 4 = "Several times a month," 5 = "Once a week," 6 = "Several times a week," 7 = "Every day."	107,488	4.80
<i>Trust</i>	A4: Would you say that most people can be trusted, or that you can't be too careful in dealing with people?	Responses are expressed on an 11-point scale ranging from 0 ("You can't be too careful") to 10 ("Most people can be trusted").	107,488	5.23
<i>Individual Characteristics</i>				
<i>Gender</i>	F2: Code sex	1 = "Male," 2 = "Female."	107,488	1.52
<i>Age</i>	F3: In what year {were you/was he/she} born?	Age is calculated based on the year of birth he/she entered.	107,488	50.98
<i>Income</i>	F41: Which letter describes your household's total income, after tax and compulsory deductions, from all sources?	Responses are expressed on an 11-point scale ranging from 0 ("1st decile") to 10 ("10th decile").	107,488	5.47
<i>Education</i>	F15: What is the highest level of education you have successfully completed?	Responses are divided into 27 categories according to the ISCED criteria, and the higher the education, the greater the value.	107,488	414.72
<i>Health</i>	C7: How is your health in general?	1 = "very good," 2 = "good," 3 = "fair," 4 = "bad," 5 = "very bad."	107,488	2.20
<i>Religion</i>	C15: Regardless of whether you belong to a particular religion, how religious would you say you are?	Responses are expressed on an 11-point scale ranging from 0 ("Not at all religious") to 10 ("Very religious").	107,488	4.38

Note: The ISCED coding framework is divided into six levels (Level 0: Pre-primary education; Level 1: Primary education or first stage of basic education; Level 2: Lower secondary or second stage of basic education; Level 3: (Upper) secondary education; Level 4: Post-secondary non-tertiary education; Level 5: First stage of tertiary education; Level 6: Second stage of tertiary education). The ESS is further subdivided into 27 levels under this six-level framework.

Data source: ESS, rounds 8, 9, and 10 (rounds 8 and 9 use the final updated version, and round 10 uses the updated version as of May 2023).

rounds 8, 9, and 10, conducted biennially between 2016 and 2020. The choice of the latest three waves is driven by several factors: First, the dataset for these waves covers the period of the COVID-19 pandemic, which is crucial for conducting a comparative analysis before and after the pandemic. Second, the ESS survey on Internet usage is only available for the latest three waves, making it infeasible to use earlier waves before round 8. Lastly, pooling the cross-sectional dataset enables us to increase the number of observations, leading to more refined estimations.

The dependent variable in our analysis is life satisfaction, and the primary explanatory variable is Internet usage. Following the approach of Chen et al. [82], we include control variables related to indicators related to political orientation, social engagement, and individual characteristics. Previous literature extensively confirms the significant effects of political orientation and social engagement on life satisfaction. For instance, Zhang et al. [25] found that joining a political party and having a political identity have a positive impact on life satisfaction. Viñas-Bardolet et al. [79] identified social life as an important determinant of life satisfaction and empirically confirmed its significant positive effect by using the third European Quality of Life Survey.

In our specific dataset, political orientation comprises indicators for political interest and political tendency. Social engagement includes variables related to social interaction and trust. Individual characteristics include gender, age, income, education, health, and religion. During the data processing stage, observations with “refusal,” “Don’t know,” and “Other” responses for any of the above variables are eliminated. This process results in a final dataset of 33 European countries and 107,488 observations. Table 1 provides an overview of the questions in the ESS questionnaire corresponding to our variables and presents descriptive statistics.

3.2. Method

3.2.1. Fixed-effects ordered logit model

Given that life satisfaction is measured on an 11-point scale, we employ the ordered logit model, which avoids partial information loss. In addition, the ordered probit model aligns well with our variational features and is used as the method for robustness tests in this paper. To account for the typical national differences across European countries, we control for country and year effects to mitigate the impact of time-varying characteristics at the national level [83]. Therefore, our baseline model is the fixed-effects ordered logit model, as shown in Equation (1).

It should be noted that we did not employ the multilevel logit model when using multi-period ESS data. The multilevel model is a random effects model that emphasizes the influence of second-layer variables (social or national level) on the explained variables [84]. As our focus is on the first-layer variables (individual level), the multilevel model is not suitable for estimating individual differences and does not align with our research objective. In addition, we did not use the dynamic logit model for analysis because our multi-period ESS data consists of pooled cross-sectional data, and new respondents were selected for each period. Therefore, lag analysis could not be performed as in panel data [85]. As a result, we opted for the fixed-effects ordered logit model over other logit models because it not only meets the requirements of the data structure but also provides a robust estimate of the impact of individual factors on life satisfaction, better serving the research purpose of this paper.

In Equation (1), the subscript i represents the individual, and t represents the year. y_{it}^* is the continuous latent variable, which cannot be directly measured in practical work, and once it reaches a certain threshold, the explained variable takes the corresponding value. The relationship between y_{it}^* and the dependent variable y_{it} is illustrated by Equation (2), where $r_0, r_1 \dots r_9$ are the parameters to be estimated, including the intercept ($r_0 \leq r_1 \leq r_2 \leq r_3 \leq r_4 \leq r_5 \leq r_6 \leq r_7 \leq r_8 \leq r_9$).

$Internet_{it}$ represents Internet usage. Referring to the study by Gao et al. [86], we use the average value of Internet usage in the countries of the respondents (excluding the respondents themselves) as the instrumental variable for estimation in our robustness check. This approach is based on the premise that the average value of Internet usage in the country is highly correlated with the respondents’ Internet usage. Furthermore, it is suggested that this average value, once the respondents are excluded, does not correlate with the respondents’ life satisfaction. Thus, the selected instrumental variable strictly meets the criteria for both correlation and exogeneity. X_{it} is a series of control variables, and γ_{it} is the fixed effects of country by year. μ_{it} represents the unobservable error term.

$$y_{it}^* = F(\beta_1 internet_{it} + \beta_2 X_{it} + \gamma_{it} + \mu_{it}) \tag{1}$$

$$y_{it} = \begin{cases} 0 & y_{it}^* \leq r_0 \\ 1 & r_0 < y_{it}^* \leq r_1 \\ 2 & r_1 < y_{it}^* \leq r_2 \\ 3 & r_2 < y_{it}^* \leq r_3 \\ 4 & r_3 < y_{it}^* \leq r_4 \\ 5 & r_4 < y_{it}^* \leq r_5 \\ 6 & r_5 < y_{it}^* \leq r_6 \\ 7 & r_6 < y_{it}^* \leq r_7 \\ 8 & r_7 < y_{it}^* \leq r_8 \\ 9 & r_8 < y_{it}^* \leq r_9 \\ 10 & y_{it}^* \geq r_9 \end{cases} \tag{2}$$

According to Equation (1) and Equation (2), the probability of ordered logit model can be deduced as follows:

$$P(y_{it} = 0|X) = P(y_{it}^* \leq r_0) = P(\beta_1 internet_{it} + \beta_2 X_{it} + \gamma_{it} + \mu_{it} \leq r_0) = P(\mu_{it} \leq r_0 - \beta_1 internet_{it} - \beta_2 X_{it} - \gamma_{it}) \tag{3}$$

$$P(y_{it} = 1|X) = P(r_0 \leq y_{it}^* \leq r_1) = P(r_0 \leq \beta_1 internet_{it} + \beta_2 X_{it} + \gamma_{it} + \mu_{it} \leq r_1) \tag{4}$$

$$P(y_{it} = 10|X) = P(y_{it}^* \geq r_9) = P(\beta_1 internet_{it} + \beta_2 X_{it} + \gamma_{it} + \mu_{it} \leq r_9) = 1 - P(\mu_{it} \leq r_9 - \beta_1 internet_{it} - \beta_2 X_{it} - \gamma_{it}) \tag{5}$$

Equations (3)–(5) demonstrate that the parameters $r_0, r_1 \dots r_9$ divide the probability density function into 11 intervals. Regardless of the value of the dependent variable, the probability of y_{it} is fixed under the influence of the independent variable X , since there is a common set of parameters β .

3.2.2. Propensity score matching (PSM) method

To address the estimation bias caused by the self-selection problem, we also use the PSM method for estimation. Multiple linear regression (MR) requires a clear specification of the functional relationship between dependent and independent variables; otherwise, the issue of functional form misspecification (FFM) may arise, leading to biased estimated coefficients. By contrast, PSM does not rely on explicit model-setting assumptions. Operating within the counterfactual framework, PSM constructs a “control group” similar to the “treatment group” to estimate the treatment effect. Therefore, compared with MR, PSM is a powerful tool for mitigating endogeneity and enhancing the robustness of regression results [51]. Following the rules of PSM, we divide the observations into two groups: those using the Internet (treatment group) and those not using the Internet (control group). The probability of an observation belonging to the treatment group is represented by Equation (6), where X represents the covariables. Furthermore, we can calculate the participant average treatment effect (ATT) to measure the gross payoffs of participants. Equation (7) is used to calculate the ATT of using the Internet on life satisfaction, with subscript 1 referring to the

experimental group and subscript 0 to the control group.

$$P_{it}(X) = Pr(\text{Internet}_{it} = 1 | X_{it}) \tag{6}$$

$$ATT = E(\text{satisfaction}_1 | \text{Internet}_{it} = 1) - E(\text{satisfaction}_0 | \text{Internet}_{it} = 1) \tag{7}$$

Specifically, $P_{it}(X)$ is the probability of the sample in the treatment group. In Equation (7), ATT represents the average effect of improving life satisfaction of users who use the Internet; $E(\text{satisfaction}_0 | \text{Internet}_{it} = 1)$ represents the potential outcomes for users who use the Internet if they do not, which is also an unobservable value; $E(\text{satisfaction}_1 | \text{Internet}_{it} = 1)$ represents the real observed outcome under the usage of the Internet.

4. Empirical result

In this section, we conducted a series of regressions to examine the impact of Internet usage on life satisfaction, both before and during COVID-19, as well as its influencing mechanisms and heterogeneity analysis, based on the aforementioned hypotheses. We also provided robustness tests to improve the model’s reliability.

4.1. Pre-regression testing

Before proceeding to the baseline regression, we carried out both variance inflation factor (VIF) and maximum likelihood (ML) tests. The VIF test revealed a maximum VIF value of 1.67 and a mean VIF value of 1.24 for all independent variables (shown in Table 2), which are significantly below 10. This indicates that the presence of multicollinearity is not a concern in our analysis. The ML test showed that the null hypothesis was rejected ($\text{Chi}^2 = 32491.64, p = 0.000 < 0.05$), suggesting that the independent variables in our model are highly effective and the model is well suited for estimation.

4.2. Baseline regressions of the internet usage impact on life satisfaction

Table 3 presents the baseline regression results. Model (1) includes no control variables, while Model (2) controls for the country-year fixed effect. Subsequently, Models (3) to (5) add all control variables, including political orientation, social engagement, and individual characteristics. The effect of Internet usage on life satisfaction decreases from 20.54 % to 1.85 % as the control variables are progressively added, but the coefficient remains significant and positive. These consistent significant and positive effects of Internet usage on life satisfaction are observed across the models, thereby supporting H1. This result aligns with previous findings from Lu and Kandilov [32] and Zhong et al. [33].

Models (6) and (7) investigate the changes in effects before and during COVID-19. Before COVID-19, the coefficient is 0.0082 but not significant, and it is 0.0319 and significant during COVID-19. These findings indicate that Internet usage positively affects life satisfaction during COVID-19, whereas there is no significant relationship in the regression before the pandemic, thus supporting H2.

Moreover, the control variables in the baseline regression also exhibit robustness. The coefficients and significance of the control variables show minimal changes from Model (3) to Model (5), indicating that our model construction is reasonably justified. According to Model

Table 2
Variance inflation factor test.

Variable	VIF Value	Variable	VIF Value
Internet Usage	1.67	Age	1.09
Political Interest	1.57	Education	1.09
Political Tendency	1.32	Income	1.09
Social Interaction	1.29	Health	1.06
Trust	1.27	Religion	1.03
Gender	1.18	Mean VIF	1.24

(5), we find that political interest is not significantly associated with life satisfaction, suggesting that it is not a key factor in explaining variation in life satisfaction. However, a “right” political tendency shows a positive and significant association with life satisfaction. Additionally, respondents with higher social integration are more likely to report higher life satisfaction. Trust has the same effect as social integration.

Individual characteristics also display a significant impact on life satisfaction. Females are more likely to have higher life satisfaction, and as respondents age, they tend to be more satisfied with their lives. High-income earners also demonstrate a greater likelihood of having higher life satisfaction. Education level, although showing a small negative effect, still significantly impacts life satisfaction. Health status has a strong, positive, and significant association with life satisfaction. It should be noted that although the coefficient of the health variable is negative, health status is positively correlated with life satisfaction. This is because in the ESS questionnaire data, the worse the health status, the higher the score of the health variable, as shown in Table 1. Lastly, more religious respondents tend to have higher life satisfaction.

Given the nature of the ordered logit model coefficients, which do not lend themselves to direct interpretation, we use marginal effects to evaluate the three levels of life satisfaction, drawing on Shao [87] and Liu et al. [88]. Table 4 reports the results of marginal effects and illustrates the probability of shifts within the dependent variables of being unsatisfied, fairly satisfied, and satisfied. We find a gradual decrease in the marginal effects of Internet usage on life satisfaction. Specifically, an increase of one standard deviation (0.7016) in Internet usage raises the probability of being unsatisfied and fairly satisfied by 3.77 % (0.0537×0.7016) and 2.01 % (0.0287×0.7016), respectively, while it lowers the probability of being satisfied by 2.01 % (-0.0287×0.7016).

Following this, we present the results for 28 individual European countries. Fig. 2 displays the impact of Internet usage on life satisfaction for these countries before and during COVID-19. The cranberry line represents the regression results before COVID-19, while the dark navy line denotes the results during COVID-19. The length of the line segment indicates the 95 % confidence interval, and the black points represent the point estimates for each regression. As observed, the point estimates generally move upward for most country samples in the post-pandemic period, indicating that in most European countries, the outbreak of COVID-19 and the subsequent anti-pandemic policies promoted digitalization and further increased individuals’ life satisfaction.

Bulgaria, the Czech Republic, Ireland, the Netherlands, and Slovakia show a significant strengthening of the positive effect of Internet usage on life satisfaction after the pandemic. In Austria, Finland, Israel, and Sweden, the originally significant negative effect was no longer significant after the pandemic, suggesting that the pandemic helped reduce the negative impact of Internet usage on life satisfaction in these countries. By contrast, in Lithuania, the positive effect of Internet usage on life satisfaction was significant before the pandemic but no longer significant after the pandemic. A possible explanation for this could be the frequent Internet outages in Lithuania during the pandemic. The malfunctioning of online systems in Lithuania during the COVID-19 pandemic was cited by 81.2 percent of respondents as the main factor that made them feel exhausted, the highest proportion among all factors that affect life satisfaction [89].

The evidence from most countries indicates that the positive impact of Internet usage on life satisfaction becomes stronger during COVID-19, or that the negative impact becomes weaker. These findings collectively support a stronger positive effect of Internet usage on life satisfaction during COVID-19, which also aligns with H2.

4.3. Influencing mechanisms of the impact of internet usage on life satisfaction

To confirm the series hypothesizes of H3, we use a two-step approach, following Baron and Kenny [90], to verify the mediating effect of the mechanism. Referring to the two-step approach of Zhang and

Table 3
Baseline regression.

<i>Dep. Var.</i>	Full Sample	Full Sample	Full Sample	Full Sample	Full Sample	Before COVID-19	During COVID-19
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Life Satisfaction							
Internet Usage	0.2054*** (0.004)	0.1352*** (0.004)	0.1319*** (0.004)	0.0855*** (0.004)	0.0185*** (0.005)	0.0082 (0.006)	0.0319*** (0.008)
<i>Political Orientation</i>							
Political Interest			-0.1032*** (0.006)	-0.0550*** (0.007)	0.0054 (0.007)	0.0083 (0.009)	-0.0011 (0.011)
Political Tendency			0.0956*** (0.002)	0.0992*** (0.002)	0.0765*** (0.002)	0.0740*** (0.003)	0.0799*** (0.004)
<i>Social Engagement</i>							
Social Interaction				0.1867*** (0.004)	0.1662*** (0.004)	0.1649*** (0.005)	0.1685*** (0.006)
Trust				0.1421*** (0.003)	0.1130*** (0.003)	0.1211*** (0.003)	0.1009*** (0.004)
<i>Individual Characteristics</i>							
Gender					0.0719*** (0.011)	0.0825*** (0.014)	0.0598*** (0.018)
Age					0.0138*** (0.000)	0.0113*** (0.000)	0.0174*** (0.001)
Income					0.1080*** (0.002)	0.1087*** (0.003)	0.1081*** (0.004)
Education					-0.0001*** (0.000)	-0.0002*** (0.000)	-0.0001 (0.000)
Health					-0.6100*** (0.007)	-0.6117*** (0.009)	-0.6095*** (0.012)
Religion					0.0413*** (0.002)	0.0427*** (0.002)	0.0395*** (0.003)
Country-Year Fixed Effects	NO	YES	YES	YES	YES	YES	YES
Observations	107,488	107,488	107,488	107,488	107,488	66,766	40,722
Pseudo R-Squared	0.0069	0.0319	0.0360	0.0496	0.0746	0.0789	0.0682

Note: *, **, and *** indicate significance at the 10 %, 5 %, and 1 % levels, respectively. Standard errors are shown in parentheses. The same applies to Tables 4–6.

Table 4
Marginal effects.

<i>Dep. Var.</i>	Unsatisfied	Fairly satisfied	Satisfied
	(1)	(2)	(3)
Life Satisfaction			
Internet Usage	0.0537*** (0.018)	0.0287*** (0.010)	-0.0287*** (0.006)
Control Variables	YES	YES	YES
Country-Year Fixed Effects	YES	YES	YES
Observations	7420	23,728	76,340
Pseudo R-squared	0.0360	0.0225	0.0361

Note: We divide the 0–10 score of the life satisfaction index into three levels (0–3 = “Unsatisfied,” 4–6 = “Fairly satisfied,” and 7–10 = “Satisfied”). Control variables are omitted due to space limitations.

Table 5
Empirical results of mediating effect.

<i>Dep. Var.</i>	Work Flexibility			Work–Life Balance			Team Engagement		
	Work Flexibility		Life Satisfaction	Work–Life Balance		Life Satisfaction	Team Engagement		Life Satisfaction
	O-logit	IV		O-logit	IV		O-logit	IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Internet Usage	0.1817*** (0.004)	0.3583*** (0.008)	0.1042*** (0.004)	-0.0365** (0.015)	-0.0190** (0.008)	0.1841*** (0.014)	0.1978*** (0.020)	0.1899*** (0.022)	0.2205*** (0.020)
Work Flexibility			0.0768*** (0.002)						
Work–life Balance						-0.4430*** (0.013)			
Team Engagement									0.2490*** (0.009)
Country-Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	100,499	100,499	100,499	23,738	23,738	23,738	12,046	12,046	12,046
Pseudo R-Squared	0.0249	0.1238	0.0374	0.0125	0.0327	0.0357	0.0107	0.0313	0.0457

Li [19] and Koçak [91], we do not include control variables in the model. Considering the models’ potential for endogeneity problems arising from dual causality, we use the average value of Internet usage in the respondents’ countries (excluding the respondents themselves) as the instrumental variable for estimation, and the results are presented in Table 5.

Model (1) and Model (2) indicate that the more frequent usage of the Internet is associated with a higher degree of work flexibility, and work flexibility also shows a significantly positive effect on life satisfaction as shown in Model (3). Hence, H3a is supported. Model (4) and Model (5) indicate that Internet usage is significantly positively related to work–life balance, and work–life balance shows a positive effect on life satisfaction, as displayed by Model (6), which confirms the results of H3b. Model (7) and Model (8) indicate that Internet usage has a significant positive effect on team engagement, and Model (9) shows that

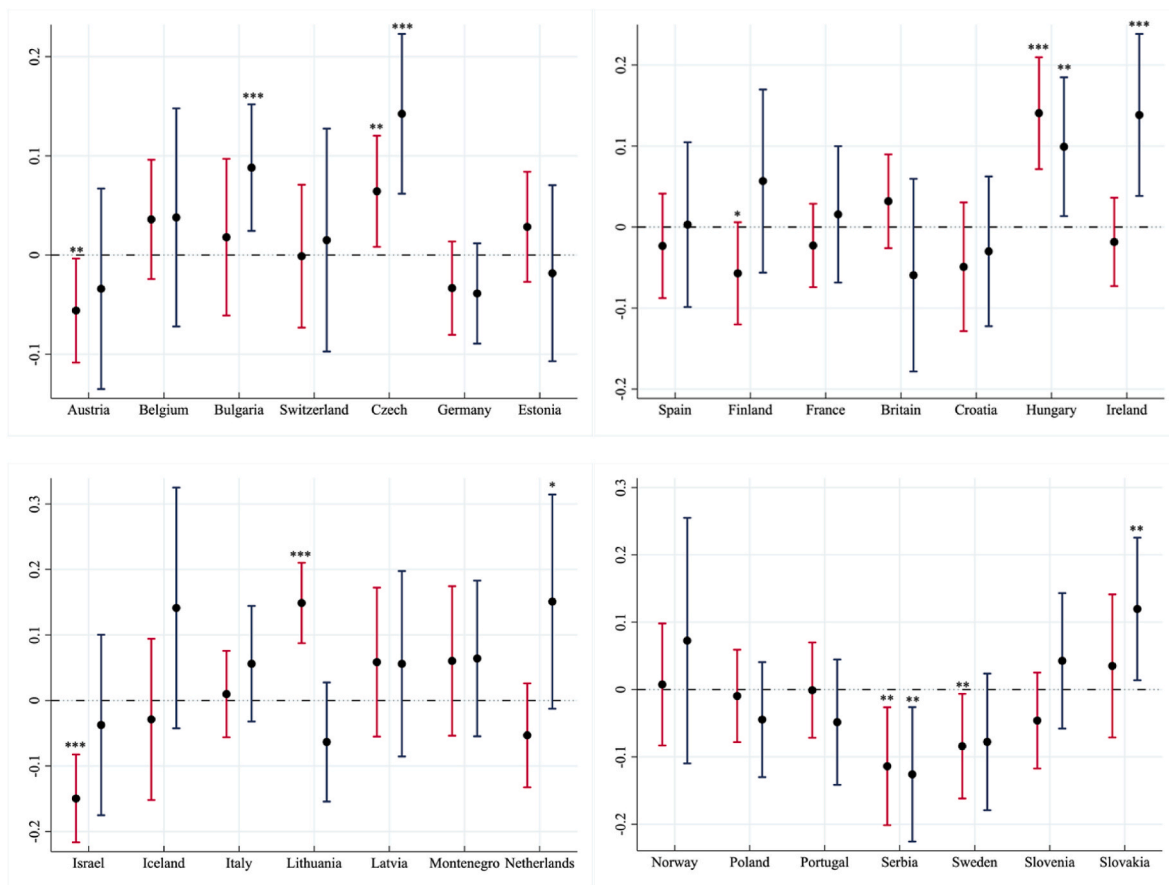


Fig. 2. Impact of Internet usage on life satisfaction for individuals across 28 European countries. *Note:* Observations from Cyprus, Denmark, and Russia were excluded from the figure because data was not available during COVID-19, and for Greece and North Macedonia, data was not available before COVID-19. Therefore, 28 countries are presented in this figure. The vertical axis shows the regression coefficients, and the horizontal axis shows the European countries. All line segments represent the coefficients of Internet usage. *, **, and *** indicate significance at the 10 %, 5 %, and 1 % levels, respectively. The following forest plots are the same.

team engagement also has a significant positive effect on life satisfaction, thus verifying the hypothesis of H3c.

4.4. Heterogeneity analysis of internet usage on life satisfaction

In this section, we conducted a series of heterogeneity analyses to investigate whether the impact of Internet usage on life satisfaction varies significantly across age, income, education, region, and occupation. The results are presented in Fig. 3.

Referring to the classification criteria used by relevant scholars for the age of respondents [92], our observations are divided into three age groups: younger age group (Age ≤ 35), middle age group (35 < Age ≤ 55), and older age group (Age > 55). The results show that all age groups have a significant positive effect on life satisfaction, and the point estimates gradually decrease with age. Therefore, H4a is also supported.

To test the hypothesis of H4b, we divided the observations into three income groups: low-income group with scores of 1–3 on the questionnaire responses, middle-income group with scores of 4–7, and high-income group with scores of 8–10. The results show a significantly positive effect in the middle-income group and high-income group, with no significant effect in the low-income group. Moreover, the point estimate is higher in the high-income group than in the middle-income group. The evidence above collectively demonstrates that a higher-income group is associated with a higher likelihood of a positive effect of Internet usage on life satisfaction, supporting H4b.

The results show a significantly positive effect in Eastern Europe and Central Europe, with no significance in Northern, Southern, and Western

Europe. However, Europe’s GDP per capita in 2021, according to the World Bank, ranked from highest to lowest: Northern Europe, Western Europe, Central Europe, Southern Europe, and Eastern Europe. The heterogeneity result of regions does not seem to correlate with the economic development level, not supporting H4c.

Since there are up to 27 categories of educational attainment of the respondents in the ESS questionnaire and to ensure each group has an adequate observation size, we divided the observations into four categories that refer to ISCED criteria. The first category is junior high school and below (Level 1), the second is senior secondary and post-secondary education (Level 2), the third is a bachelor’s degree or equivalent (Level 3), and the fourth is a master’s degree or above (Level 4). The results show a significantly positive effect at Level 2 and Level 4, with no significance at Level 1 and Level 3. However, the point estimates gradually increase in order of education level, which partially confirms H4d.

We test the hypothesis of H4e by partitioning the observations based on whether respondents are managers or not and their occupation type. The results show that Internet usage has a significant positive effect on life satisfaction for the non-manager group but not for the manager group. While managers usually have higher status and income [93], it shows that occupations with higher status are less likely to derive life satisfaction, which is contrary to H4e. In addition, the results of other groups are not significant, except for government departments and private firms, which show a significantly positive effect. However, it is difficult to conclude that occupations with higher income and status are more likely to obtain life satisfaction from Internet usage, thereby not providing support for H4e in these contexts.

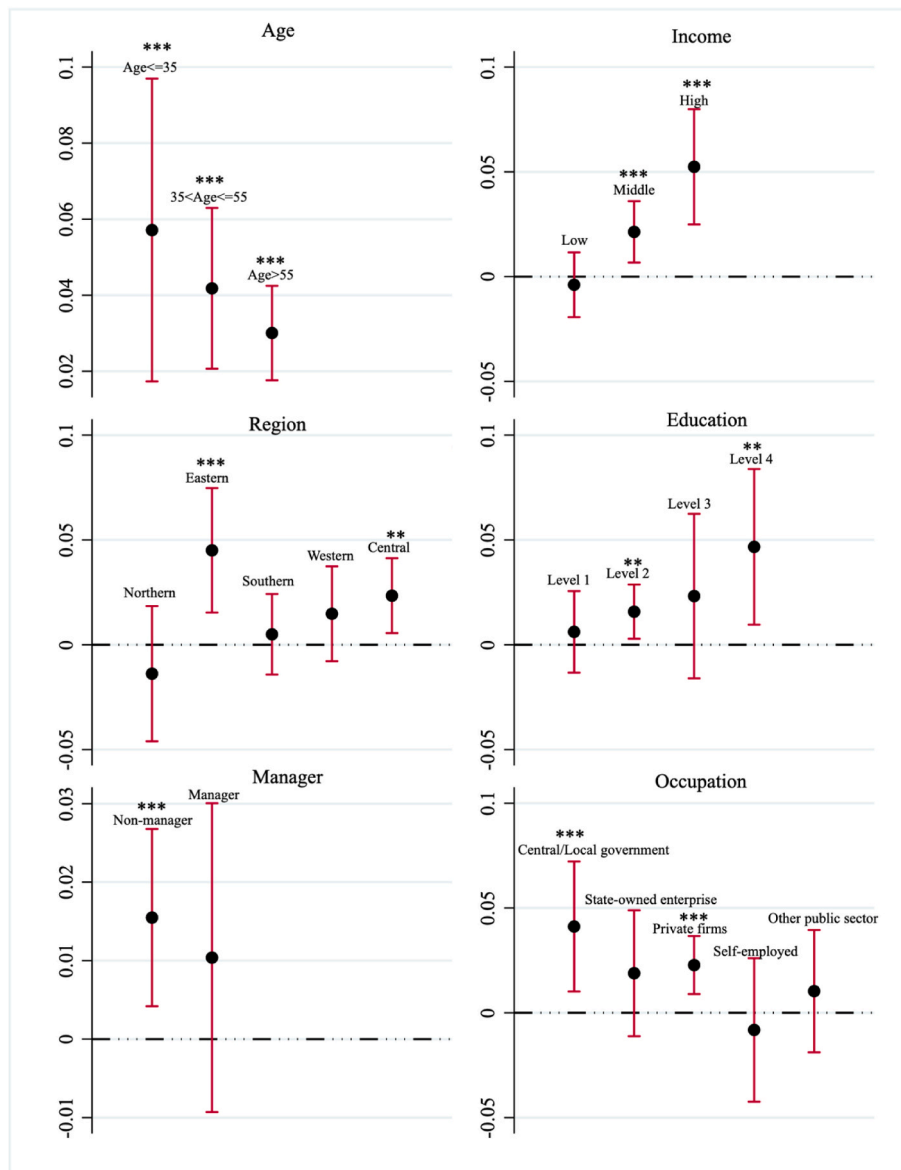


Fig. 3. Heterogeneity analysis of impact of Internet usage on life satisfaction.

Note: The observations are divided into different regions based on the national information provided by the ESS. Northern Europe includes Denmark, Finland, Iceland, Norway, and Sweden. Eastern Europe includes Estonia, Lithuania, Latvia, and Russia. Southern Europe includes Bulgaria, Spain, Greece, Croatia, Italy, Montenegro, Macedonia, Portugal, Serbia, and Slovenia. Western Europe includes Belgium, France, Britain, Ireland, and the Netherlands. Central Europe includes Austria, Switzerland, the Czech Republic, Hungary, Poland, and Slovakia. Cyprus and Israel are in the Middle East and not part of Europe; therefore, they were excluded from this analysis.

4.5. Robustness check

4.5.1. PSM estimation

We used the PSM method and other regression methods to assess the robustness of the baseline regression. PSM is considered one of the efficient means for conducting robustness analysis, and it has been widely used in numerous studies [19,33,51]. First, we categorized the observations into two groups: the experimental group, which uses the Internet, and the control group, which does not. Next, we matched respondents with similar characteristics from the control group to those in the experimental group based on age, gender, education, health, and income. Finally, we investigated the significant differences between the experimental and control groups. The regression results are displayed in Model (1) in Table 6. After undergoing the PSM process, the standard error deviation is significantly reduced (shown in Fig. 4, left), leading to more robust regression results. Fig. 4 (right) displays the specific

Table 6 Robustness check.

Dep. Var.	PSM (O-logit)	IV		O-probit	OLS
		2SLS	LIML		
Life Satisfaction	(1)	(2)	(3)	(4)	(5)
Internet Usage	0.0133** (0.006)	0.0328*** (0.006)	0.0328*** (0.006)	0.0074** (0.003)	0.0249*** (0.005)
Control Variables	YES	YES	YES	YES	YES
Country-Year Fixed Effects	YES	YES	YES	YES	YES
Observations	59,719	107,488	107,488	107,488	107,488
(Pseudo) R-squared	0.0755	0.2612	0.2612	0.0704	0.2605

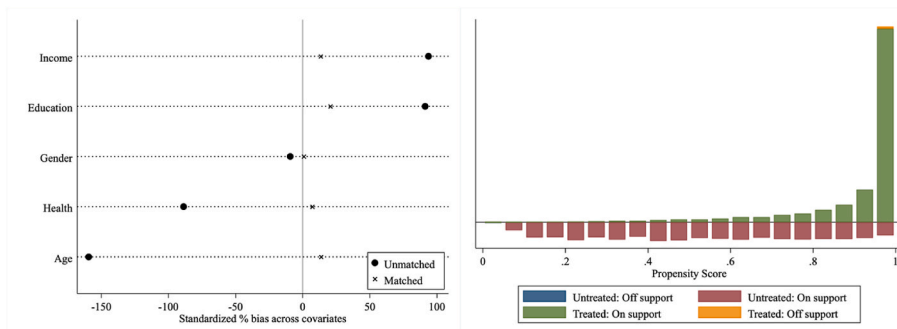


Fig. 4. Standardizes deviation plot and common range of values for PSM.

matching results, where only a few observed values fall outside the common range of values, resulting in a minimal loss of observations during the matching process.

4.5.2. Instrumental variable estimation

To consider the endogeneity problem stemming from the dual causality between Internet usage and life satisfaction, we use instrumental variable estimation for the robustness check. The results are shown in Model (2) and Model (3) in Table 6. Model (2) uses 2SLS for instrumental variable estimation, while Model (3) uses maximum likelihood estimation (LIML). The results of the instrumental variable regression are consistent with those of the baseline regression, which indicates that Internet usage plays an important role in boosting life satisfaction. This consistency affirms the robustness of the baseline regression results.

4.5.3. Ordered probit model and OLS

In addition, to further examine the robustness, we employ the ordered probit model as described by Bao et al. [94], and the OLS model as referred to Georgellis et al. [81] for robustness analysis. These analyses are presented in Model (4) and Model (5) of Table 6, respectively. Both models yield results indicating a significantly positive effect of Internet usage on life satisfaction, further affirming the robustness of the previous findings.

5. Discussion

5.1. Why is there no significance between internet usage and life satisfaction before COVID-19?

The results from the baseline regression reveal that Internet usage have a significant positive effect on life satisfaction during COVID-19, whereas this effect is not significant before COVID-19. Several factors related to European lifestyles may account for this discrepancy. Before COVID-19, Europe displayed a less consumerist culture and has lower levels of digitalization compared with the period following the outbreak, when digitalization accelerated dramatically. The pandemic triggered a rapid shift in digital adoption, with Europe's digital usage soaring from 81 percent to 95 percent – a growth that would have typically taken two to three years in most industries at pre-pandemic growth rates [95]. Supporting evidence from ESS data confirms this trend: During COVID-19, the percentage of respondents using the Internet every day increased from 63.31 percent to 70.38 percent, while the proportion of respondents who never use the Internet decreased from 16.25 percent to 10.25 percent. Before COVID-19, the limited digitalization might have resulted in a modest impact of Internet usage on life satisfaction since various activities, like shopping, entertainment, and other behaviors, could be conveniently carried out offline. In addition, there are some negative effects, such as increased Internet comparison [24] and heightened anxiety about environmental pollution and public affairs [25]. When the negative and positive effects were comparable, the impact of Internet usage on life satisfaction was not significant.

5.2. Why doesn't the positive effect of internet usage on life satisfaction intensify with national economic development?

Empirical results reveal that the impact of Internet usage on life satisfaction is not significantly stronger in countries with higher levels of economic development. The most substantial positive effect is found in Eastern and Central Europe. This phenomenon can be attributed to two potential reasons: a) Eastern and Central Europe, despite their lower levels of economic development, tend to be collectivist because they are nations in social transition with weak institutional trust. As a result, people in these regions prioritize group cohesion and redistribution [96]. By contrast, Western, Northern, and Southern European countries are considered non-transition countries and are more individualistic [97]. In individualistic societies, where values of self-achievement and meritocracy prevail [71], people are more inclined to compare themselves with others and know their position in society. Consequently, Internet usage facilitates such comparisons, but the overall effect of increased comparisons on life satisfaction is generally negative [24]. b) The impact of Internet usage on life satisfaction is not solely dependent on the absolute level of Internet development but also on its rate and direction. Despite higher economic development leading to advanced digital infrastructure in certain European Union countries, research by Natalia [98] found that the most digitalized Nordic countries experienced a reduction in Internet usage rate during the pandemic in 2020. This observation suggests that, because of fluctuations in Internet usage rates, the positive effect of Internet usage on life satisfaction might be relatively modest in countries with high levels of economic development. This finding is corroborated by the existing literature. Vatsa et al. [31] assert that the area with the lowest income, characterized by the lowest level of consumption diversity, stands to benefit the most from having Internet access. Similarly, Liang and Li [99] reveal that Internet usage has a larger impact on rural households, which are typically situated in areas of lower economic development.

5.3. Why is there a significant positive effect in the non-manager group and no significance in the manager group?

The non-manager group exhibits a significant effect, while such significance is not observed in the manager group due to the distinct work mode of these two groups. As noted by Dierdorff and Morgeson [100], the rewards in high occupations depend on performance, which is generally linked to the successful maintenance of social networks. To secure their rewards, managers often need to engage in people management and assume responsibility for team members, which can be stressful and reduce the time spent on the Internet [81]. Consequently, managers primarily rely on socializing and do not heavily depend on the Internet; thus, the improvement of digitalization has no substantial impact on their life satisfaction.

By contrast, non-manager employees worked from home through the Internet during the pandemic, which provided them with increased efficiency and time flexibility, leading to enhanced life satisfaction [101].

However, managers have traditionally enjoyed flexible working hours and locations [102], and therefore, the level of digitalization does not significantly affect their life satisfaction through increased work flexibility. As a result, the effect of Internet usage on life satisfaction is weaker in the manager group than in the non-manager group.

5.4. How does occupation type matter for the impact of internet usage on life satisfaction?

While income is a significant factor influencing the impact of Internet usage on life satisfaction, Shawn et al. [103] emphasize that occupations play a more critical role than income in this regard. To understand this empirical finding, we can examine it from the perspective of occupational mobility, as referred to by Zhou et al. [104]. Full-time employees are likely to spend more time interacting with co-workers on the Internet than their non-full-time counterparts, and having a stable full-time job is considered desirable, leading to higher life satisfaction [105]. Conversely, self-employed individuals lack stable co-workers to engage with through social media, making them less likely to derive life satisfaction from the Internet, which aligns with the insignificant and smallest point estimates observed in the empirical results.

Research also indicates that government civil servants typically have a serviced-oriented mindset, making them more prosocial than their counterparts in the for-profit sector [106]. Internet usage can enable them to flexibly address meaningful yet complex and repetitive tasks, such as engaging with the net citizens, staying informed about social issues, caring about societal challenges, and listening to the voice of civil society [107]. And owing to their prosocial nature, government civil servants are more inclined to experience positive effects rather than negative ones when using the Internet [108]. Consequently, working in the central or local government is more likely to result in higher life satisfaction than other occupations.

In addition, private firms, driven primarily by profit, can quickly adapt their development strategies for digital transformation in response to the COVID-19 pandemic [109]. They also have fewer bureaucratic procedures than state-owned enterprises and other public sectors. Because state-owned enterprises and other public sectors prioritize responsibility to the government and society, they may be less profitable than private firms [110]. The additional profits generated by businesses' digitalization efforts can spill over to employees through increased salary levels, contributing to higher life satisfaction. As a result, employees of private firms are more likely to report greater life satisfaction in the face of the pandemic than their counterparts in state-owned enterprises and other public sectors.

5.5. What can we learn from the changes in nexus between internet usage and life satisfaction during the COVID-19?

This study illustrated a significant increase in the probability and frequency of people using the Internet during COVID-19 and revealed a stronger positive effect of Internet usage on life satisfaction. We can draw two insights from the empirical results. On the one side, consider there was no significant relationship between Internet usage and life satisfaction in Europe before the pandemic, and the relationship only became significant after the outbreak of COVID-19, during which people were forced to shop and work at home. In this line, digitalization was promoted and people's life satisfaction was improved. It is thus can be prospected that the positive impact of Internet usage on life satisfaction could be diminished and even disappeared in the post-pandemic era without the lockdown policy. In this light, measures should be taken to remain such a positive effect. On the other side, as the level of digitization has increased during the pandemic, the digital divide has widened in the meanwhile [111,112], which has important implications for individual and social well-being [113]. As our findings show, the young, the rich, the well-educated, Eastern and Central Europeans,

non-managers, and employees of central/local governments and private firms were benefited from this digital transformation, while other groups were digitally deprived. In this light, more attention should be paid to narrowing the digital gap for a just digital transformation [114, 115].

6. Conclusion and policy implications

6.1. Conclusion

In this study, we explored the relationship between Internet usage and life satisfaction by using the fixed-effects ordered logit model and the PSM method with data from the 2016, 2018, and 2020 ESS datasets. The findings of the study are as follows: (a) Internet usage positively contributes to life satisfaction. We used various regression methods, including logit, probit, OLS, 2SLS, LIML and PSM, and consistently obtained robust results. (b) The marginal effects of Internet usage on life satisfaction gradually decreases. (c) The two-step approach reveals that work flexibility, work-life balance, and team engagement play crucial mediating roles in the nexus between Internet usage and life satisfaction in Europe. (d) The positive effect of Internet usage on life satisfaction becomes significantly more pronounced during the COVID-19 pandemic, whereas the effect was not as prominent before the pandemic. (e) Factors such as a more "right" political tendency, higher social integration, and increased levels of trust are associated with higher life satisfaction. In addition, age, income, health, and religion show positive correlations with life satisfaction, while education displays a negative correlation. (f) The heterogeneity analysis demonstrates that individuals with higher income, higher education levels, and younger age experience a stronger positive effect on life satisfaction through Internet usage. Moreover, employees in government departments and private firms derive a stronger impact on life satisfaction from Internet usage than other types of occupation. Furthermore, non-managers experience a stronger effect on life satisfaction from Internet usage than managers.

6.2. Policy implications

The conclusions drawn in this paper not only analyze the impact of Internet usage on life satisfaction from various perspectives but also provide strong support for comprehensive improvements in life satisfaction and for the development of the Internet industry. The main policy recommendations of this study are as follows.

- a) The EU should prioritize the enhancement of digitalization, especially in European countries with low levels of digital development. Increasing the degree of digital development can significantly elevate people's life satisfaction and contribute to overall well-being. To achieve this goal, the following measures are proposed: First, the EU should focus on developing a large pool of digitally skilled citizens and fostering highly professional digital talent. Second, there should be an emphasis on building secure, high-performance, and sustainable digital infrastructure. The aim should be to achieve widespread 5G network coverage in densely populated areas and pave the way for the eventual development of 6G. Third, national governments should extend the necessary support for the digital transformation of enterprises. This can be achieved by promoting the usage of cloud computing services, big data, and artificial intelligence, while also encouraging innovation and improving financing channels to foster the growth of unicorns. Finally, there should be a concerted effort to promote the digitalization of public services. Key public services, such as e-ID and e-health, should be available online.
- b) It is also necessary to explore the Internet's potential to enhance work capacity and flexibility. This can be accomplished by encouraging widespread participation in online learning and facilitating the development of digital workforce platforms. As highlighted earlier,

improving work flexibility, work–life balance, and team engagement through Internet usage is crucial to enhancing life satisfaction and the efficiency of social operations. Therefore, harnessing the rapid development of the Internet is vital to creating more jobs and elevating the quality of employment to keep pace with the Internet era.

- c) National governments should formulate comprehensive digital development plans to ensure equal access to the digital dividend across different income groups. The heterogeneity analysis found that the positive impact of Internet usage on life satisfaction is relatively low for low-income groups. In light of this, promoting digital development in Europe must involve the following actions: Strengthening public welfare counseling and training for low-income groups on the Internet to improve their basic digital literacy; improving the accessibility of digital products; encouraging financial institutions to provide digital products and services tailored to the needs of low-income groups and expanding the coverage of digital finance, which will help leverage digital dividends to uplift the living standards of all residents, thereby ensuring universal benefits for the population.
- d) State-owned enterprises and other public sectors should embrace digitalization. First, they should promote digital thinking among their employees, making them fully aware of the importance of digital transformation. Second, establishing digital infrastructure, including data centers and cloud computing platforms, is essential. Moreover, for self-employed individuals, using the Internet for professional training and acquiring new skills is a crucial means to enhance life satisfaction. At the same time, it is necessary to standardize Internet behavior and cultivate a harmonious online environment.
- e) Managers should further digitalize their companies in order to enhance profitability. First, by using advanced office software, they can improve employee productivity and prevent issues of uncoordinated communication and process disruptions stemming from a lack of digital tools. Second, fostering Internet usage habits among employees is crucial; this includes conducting regular online office training, testing and encouraging the improvement of office software usage skills, and mitigating the risk of business interruptions resulting from public emergencies. Lastly, to better accommodate employees with lower satisfaction, managers should focus on their needs for a networked office environment, as their marginal utility from Internet usage is higher, which can also lead to greater profits for the company.

6.3. Limitations and future research

The paper has some limitations, mainly focused on two points: (a) While the paper includes a considerable amount of heterogeneity analysis, it only discusses the sources of heterogeneity based on relevant literature without conducting the necessary econometric tests. For example, the paper argues that individuals with higher incomes and education levels might have a greater need for Internet usage, but this hypothesis lacks testing due to the lack of relevant data to measure the need for Internet usage. (b) The endogeneity problem of the model requires further attention. Like many studies analyzing life satisfaction, this paper may still encounter issues with dual causality. Life satisfaction, being a subjective variable, is influenced by numerous factors and, in turn, has an impact on various aspects of life. If an increase in life satisfaction leads to a better state of enjoying online entertainment, dual causality could introduce endogeneity in the model, rendering the estimators inconsistent. Despite using fixed-effects, PSM methods and instrumental variable estimation to address endogeneity in this paper, some endogeneity issues remain challenging to eliminate.

Considering the limitations mentioned above, future research can focus on the following aspects: (a) Enrich the subjective questions in the questionnaire. In various questionnaires, there were fewer questions

related to the happiness of human life, with a prevalence of more objective questions about family and income. As society increasingly prioritizes mental health issues, incorporating more relevant questions in questionnaires is fundamental for scientific studies and can facilitate more logical and compelling research in related fields. (b) For research involving highly subjective variables like life satisfaction, future studies can explore more exogenous instrumental variables or natural experiment methods to further address the endogeneity problem of data and improve the scientific rigor of the models.

CRedit authorship contribution statement

Ying Jiang: Writing – review & editing, Writing – original draft, Resources, Investigation, Funding acquisition. **Yong Xie:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Qinglong Shao:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition, Conceptualization.

Data availability

Data will be made available on request.

Acknowledgements

The authors appreciate the support from Alexander von Humboldt Foundation (CHN 1194898 HFST-P)." And link this as gs: Alexander von Humboldt Foundation gs no: CHN 1194898 HFST-P

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.seps.2024.102007>.

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