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Online Networks and Subjective Well-Being

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I. INTRODUCTION

The use of social networking sites (SNS) has increased dramatically in the last decade. According to Pew Research Center (PRC) data, 80% of American online adults are active members of at least one social network. Facebook is by far the most popular online social network (71% of online adults), but multi-platform use is also on the rise: 52% of online adults now use two or more social media sites. These figures have increased strikingly since February 2005, when PRC began monitoring Internet use in the U.S.

The consumption boom of SNS suggests that people receive, or at least expect, great utility in return. The utility of joining a network is generally related to the promise of strengthening members' social capital (Bourdieu, 1980, 1986; Coleman, 1990), which is an asset for the provision of social support, the creation of contacts potentially facilitating access to privileged information, jobs and credit, and the promotion of offline socialization (see for example Becchetti et al., 2008; Jackson et al., 2012).

Given the rise in SNS consumption, it is important to assess whether it provides the utility it promises or, in other terms, how it relates to the well-being and the social capital of users. At the individual level, the literature commonly

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separates structural social capital, given by networks of relationships, commonly measured through indicators of interpersonal interactions, from the cognitive dimension, given by people's beliefs and perceptions, and usually measured through indicators of trust in others (Uphoff, 2008). The structural and cognitive dimensions of social capital react to stimuli, such as the consumption of SNS, in different ways (Sabatini, 2008).

We perform an empirical investigation into the relationships among SNS use, the two dimensions of social capital and individual happiness, a proxy of utility (Helliwell and Huang, 2009). Our results suggest that the consumption of SNS exerts conflicting pressures on face-to-face interaction and social trust which entail unexpected consequences on subjective well-being. While the relation between SNS use and offline interaction has the expected, positive, sign, the use of SNS has a negative correlation with trust, which is arguably responsible for a case of utility misprediction.

To study how SNS use relates to social capital and well-being, we employ a nationally and regionally representative sample of the Italian population including the 2010, 2011 and 2012 waves of the Multipurpose Survey on Households (MHS) provided by the Italian National Institute of Statistics (Istat). This is the first national survey containing information both on the use of SNS and about the different dimensions of social capital. We use Ordinary Least Squares (OLS) to check the partial correlations among our variables of interest. Endogeneity in the use of SNS is then addressed in a Two-Stages Least Squares (TSLS) framework by exploiting technological characteristics of the pre-existing voice telecommunication infrastructures that exogenously determined the availability of broadband for high-speed Internet. In addition, we employ structural equation modelling (SEM) to disentangle the direct effect of SNS use on well-being from its indirect effect possibly mediated by the impact of SNS use on trust and face-to-face interaction.

Our work contributes to the literature in three ways: we investigate the relationship between the use of SNS, well-being, and social capital using a large and nationally representative sample; we attempt to account for endogeneity exploiting the exogenous variation in fast Internet coverage in respondents' area of residence; we interpret our results in light of theoretical arguments and previous evidence explaining why the use of SNS might affect social capital and subjective well-being.

The paper is organized as follows: in Sections II and III we review the literature on SNS and social capital and subjective well-being, respectively. Section IV describes data and the empirical strategy. Sections V and VI report and discuss the partial correlations and the test of causality for the relationship between the use of SNS and well-being. Section VII illustrates the results accounting for the indirect effects through which the use of SNS may affect people's well-being, while the last section summarizes our results and concludes the paper.

II. SNS AND SOCIAL CAPITAL

People join networks to get the benefits of being connected with others. For example, the pleasure of social interaction, the alleviation of loneliness, the provision of mutual assistance, the acquisition of information, the creation of contacts that may turn useful when looking for a job or for credit. In a word, the main reason for joining a network is the strengthening of individual social capital (see for example Bourdieu, 1986, Coleman, 1990). While the utility of membership in physical networks has been proven by many empirical studies (e.g. Smith et al., 1998; Becchetti et al., 2008; Danzer Ulku, 2011, and Growiec and Growiec 2016), we have a limited knowledge of the role of virtual networks.

A few economic studies investigated the effect of access to fast Internet on aspects of social capital such as face-to-face interaction, civic engagement, and voting behavior but, due to lack of data, they could not address the possible role of SNS. Based on German Socio-Economic Panel data, Bauernschuster et al. (2014) found that having broadband at home has positive effects on individuals' social interactions, manifesting in a higher frequency of visiting theatres, opera and exhibitions, and in a higher frequency of visiting friends. Pénard and Poussing (2015) found ambiguous results about the relationship between online investments in social capital and the development of face-to-face interactions among Luxembourg Internet users. Using data on Italian municipalities, Campante et al. (2013) found that the diffusion of broadband led, initially, to a significant decline in electoral turnout in national parliamentary elections, which was reversed in the 2013 elections, the first round that took place after the boom of SNS use. Falck et al. (2014) found that the progressive increase in DSL availability significantly decreased voter turnout in German municipalities. Analysing German municipality-level data for the period 2002–2005, Czernich (2012) obtained the opposite result that Internet broadband fosters electoral participation.

Sabatini and Sarracino (2014) used Italian cross-sectional data to carry out the first study specifically focusing on SNS. Their results suggested that online social networks may be used to preserve and consolidate existing relationships and that the use of SNS may play a role in preventing social isolation.

While online networks' support to the development and strengthening of offline relationships is commonly acknowledged in the literature, there still is disagreement about the possible effect of SNS use on the cognitive components of social capital, such as social trust.

An empirical assessment of the relationship between Internet use and trust was carried out by Uslaner (2004) drawing on a 1998 survey by the Pew Center for The People and The Press, and a 2000 survey by the Pew Internet and American

Life Project. At the time the author did not find evidence of any significant association between Internet use and lack of trust.

The first two studies on online networks and trust that were carried out after the advent of Facebook and other online social networks, however, reached opposing results and pointed out the need to further investigate how the use of SNS relates to social capital and well-being. Sabatini and Sarracino (2015) found that the use of SNS is significantly and negatively correlated with trust in unknown others and in public institutions in Italy for the period 2010-11. Antoci et al. (2016) explained the possibly detrimental effects of the use of SNS as a consequence of online incivility, a widespread phenomenon including aggressive and disrespectful behaviors, vile comments, harassment, and hate speech that makes online social environments potentially hostile for users (Rainie et al., 2013; Duggan, 2014). The relevance of this phenomenon is illustrated by the PRC, which reports that non-negligible proportions of SNS users do witness bad behavior on those sites. 49% of SNS-using adults said they have seen mean or cruel behavior displayed by others at least occasionally (Rainie et al., 2013). According to a recent survey on online harassment, 73% of adult Internet users have witnessed someone being harassed in some way in SNS and 40% have personally experienced it. 60% of Internet users said they had witnessed someone being called offensive names in SNS, 53% had seen efforts to purposefully embarrass someone, 25% had seen someone being physically threatened, and 24% witnessed someone being harassed for a sustained period of time. "Fully 92% of Internet users agreed that the online environment allows people to be more critical of one another, compared with their offline experiences". (Duggan, 2014: p. 1).

The roots of online incivility have been addressed in the early psychological literature on Internet-mediated communication, which suggested that, in online social interactions, messages are depersonalized. This encourages stronger or more uninhibited text and more aggressive behaviors. Kiesler et al. (1984) observed that computer-mediated interaction entails deindividuation, anonymity, reduced self-regulation, and reduced self-awareness. These phenomena have been found to be conducive to disinhibition and lack of restraint (Diener, 1979), which entail a higher propensity for aggressive and offensive behaviors in respect to face-to-face interactions (Sproull and Kiesler, 1998; Lea et al., 1992).

Sabatini et al. (2015) experimentally deepened the link between Facebook use and the possible deterioration in users' trust. Based on laboratory experiments, the authors found that men treated with online incivility in a Facebook environment exhibit significantly lower levels of trust. For women, on the other hand, Facebook-related stimuli are associated with a significantly less trusting behavior in trust games, independently from the possible experience of online incivility.

III. SNS AND WELL-BEING

In one of the seminal papers on the effects of SNS use, Steinfield et al. (2008) analysed the role that Facebook may play in reducing inequalities in well-being in a panel of undergraduate students of a U.S. university. The authors found that life satisfaction and self-esteem serve to moderate the relationship between the intensity of Facebook use and bridging social capital. Those with lower self-esteem gained more from their use of Facebook in terms of bridging social capital than participants with higher self-esteem, probably because Internet-mediated communication helps coping with social anxiety. Other studies pointed out that the consumption of Facebook may entail unexpected side effects related to the negative externalities produced by other SNS users. Some authors suggested that using online social networks stimulates social comparisons in a way that may be detrimental for self-esteem and life satisfaction. Based on World Values Survey data, Lohmann (2015) found that individuals who regularly use the Internet as a source of information derive less satisfaction from higher incomes. The author suggested that Internet access might raise material aspirations thereby worsening people's satisfaction with their income position. Based on Eurobarometer and on Italian MHS data, Sabatini and Sarracino (2016) found that SNS users have a higher probability to compare their achievements to those of others, resulting in lower satisfaction with their income. Using a survey conducted on a representative sample of French Facebook users, Pénard and Mayol (2015) showed that Facebook can interfere with subjective well-being through its effects on self-esteem. People who give strong value to being liked on Facebook tend to be more dissatisfied with their life. This suggests that Facebook use can exacerbate frustration and envy. Based on Dutch data from the Longitudinal Internet Studies for the Social Sciences panel, Arampatzi et al. (2016) provided empirical evidence of a negative association between the numbers of hours spent on SNS and happiness for SNS users who feel socially disconnected and lonely.

In addition, the use of SNS may indirectly be detrimental to individuals' well-being because it can negatively affect those aspects of social capital that are related to well-being. The deterioration of trust possibly resulting from the experience of online incivility (Sabatini et al., 2015; Antoci et al., 2016), for example, may have a negative impact on SWB.

In sum, available studies suggest that SNS play an important role in the relational and emotional life of users, thus plausibly affecting also their subjective well-being.

The Italian Multipurpose Household Survey allows us to assess the causal relation between the use of SNS and subjective well-being, and to test whether social capital plays a mediating role in such relationship. This is important because the strengthening of individual social capital is a source of utility that

can be reasonably considered the main motive for joining SNS. Moreover, social capital's dimensions might mediate the externalities of SNS consumption as well.

IV. DATA AND METHODOLOGY

The literature reviewed in Sections II and III suggested that the consumption of SNS might bring about positive and negative externalities. On one hand, using SNS can generate positive externalities related to the preservation and strengthening of social relations and the accumulation of social capital. On the other hand, the possibly negative externalities of SNS consumption illustrated in Section III might lead users to mispredict the utility they will derive from SNS use.

In the empirical analysis we first assess how the use of SNS relates to subjective well-being, which we consider as a proxy for utility, by using Ordinary Least Squares (OLS) and Two Stage Least Squares (TSLS) models. Then, starting from the assumption that people use SNS to strengthen their social capital – an argument in users' utility functions (Glaeser et al., 2002; Becchetti et al., 2008; Antoci et al., 2012) – we test the hypothesis that social capital mediates the effect of SNS use on well-being through a structural equations model.

We use a pooled cross-section of data drawn from the 2010, 2011, and 2012 waves of the "Multipurpose Survey on Households" (MHS) provided by the Italian National Institute of Statistics (Istat). This survey uses face-to-face interviews to investigate a wide range of social behaviors and perceptions on a nationally and regionally representative sample of approximately 24,000 households, roughly corresponding to 50,000 individuals. Population sampling is organized in two stages. First Italian towns are organized in two groups based on the size of resident population. People resident in large towns are drawn proportionally to the population size from the public registry of residents. People resident in small towns are sampled according to a two stages stratification. The first stratification concerns towns, which are sampled proportionally to their population size. The second stratification concerns the families resident in the chosen towns that are sampled with equal probability. In any case the sample size by town is not less than 23 units.

Subjective well-being is observed through the answers to the question "How satisfied are you with your life as a whole nowadays?". Answers range on a scale from 0 (extremely dissatisfied) to 10 (extremely satisfied), which is a widely adopted scale for measuring well-being (Pavot and Diener, 1993; Krueger and Schkade, 2008; OECD, 2013).

We use two measures of social capital to account for its cognitive and structural dimensions. We measure the structural dimension of social capital

through the frequency of meetings with friends. Respondents were asked to report how many times they meet their friends on a scale from 1 (in case they have no friends) to 7 (if respondents meet their friends every day). We measure cognitive social capital through social trust, as measured by binary responses to the question: "Do you think that most people can be trusted, or that you can't be too careful in dealing with people?" as developed by Rosenberg (1956).

We also use a further indicator of social trust drawn from the so-called "wallet question" to check the robustness of our findings. The wording is as follows: "Imagine you lost your wallet with your money, identification or address in your city/area and it was found by someone else. How likely do you think your wallet would be returned to you if it were found by a neighbour/the police/a stranger?" Possible responses were: "Very likely", "Fairly likely", "Not much likely", and "Not likely at all". The data on the frequency of wallet returns have been used by Knack (2001) to provide some behavioral validation for the use of answers to the "Rosenberg question" on generalized trust.

The use of SNS is observed by means of a dichotomous variable capturing respondents' participation in SNS such as Facebook and Twitter through the question: "Did you make use of social networking sites such as Facebook and Twitter in the last 12 months?". Unfortunately MHS data neither distinguish between Facebook, Twitter and other networks, nor contain information on the activities users actually carry out within these networks.

To explore the correlation between SNS use and subjective well-being, we adopted an Ordinary Least Squares (OLS) model with robust standard errors. Formally, we test the following equation:

$$SWB_i = \alpha_1 + \beta_1 \cdot SNS_i + \beta_2 \cdot friends_i + \beta_3 \cdot trust_i + \theta \cdot \mathrm{X_i} + \boldsymbol{\delta} \cdot \mathbf{Reg_j} + \boldsymbol{\varepsilon_i} \quad (1)$$

where i and j respectively indicate individual and regional observations; *SWB* is life satisfaction; *SNS* is the dummy about the use of SNS; *friends* and trust are respectively the frequency of meetings with friends, and social trust – as measured alternatively as social trust and with the wallet question; $\mathbf{X_i}$ is a vector of individual level control variables, and $\boldsymbol{\theta}$ is the respective vector of coefficients. The list of control variables includes the technology available to the respondent to connect to the Internet along with individual's age (both in linear and squared form), gender, marital status, number of children, education, work status, and the time spent in commuting (in minutes). $\boldsymbol{Reg_j}$ is the vector of regional level control variables including real regional GDP per capita, the regional level of social trust, and of frequency of meetings with friends, and $\boldsymbol{\delta}$ is the respective vector of coefficients; finally, ε_i is the error term. We use robust standard errors to control for heteroskedasticity. Table 1 provides some descriptive statistics for our variables.

Table 1

Descriptive statistics

Variable	mean	sd	min	max	obs
Life satisfaction	7.393	1.461	0	10	38712
SNS	0.46	0.498	0	1	38952
Women	0.453	0.498	0	1	38952
Age	38.98	13.25	18	89	38952
Age squared/100	16.95	11.16	3.24	79.21	38952
Marital status	1.66	0.672	1	4	38952
Educational status	2.989	0.711	1	5	38952
Occupational status	1.933	1.54	1	7	38952
Number of children	1.279	0.98	0	7	38952
Modem	0.0903	0.287	0	1	33334
DSL	0.59	0.492	0	1	33334
Fiber	0.0161	0.126	0	1	33334
Satellite	0.0823	0.275	0	1	33334
3G	0.0266	0.161	0	1	33334
USB	0.175	0.38	0	1	33334
Mobile	0.0199	0.14	0	1	33334
Fast internet connection	0.606	0.489	0	1	33334
Social trust (by region)	0.773	0.0547	0.604	0.872	38952
Frequency of meeting friends (by region)	5.081	0.165	4.826	5.516	38952
Real GDP per capita (thousands \euro 2005)	23.65	5.592	14.58	30.77	38952
Region	--	--	10	200	38952
Year	--	--	2010	2012	38952

IV.1 Controlling for endogeneity

The coefficients from equation 1 indicate the sign and magnitude of partial correlations among variables. However, our main explanatory variables can be endogenous to subjective well-being. Individual effects such as personal characteristics may be correlated with both participation in SNS and well-being. Happier people may also be more outgoing and open-minded, and may have a higher propensity for various kinds of social interactions. The inclusion of a set of control variables is intended to reduce the possible influence of omitted variables both at the individual and at the local level. However, this is not enough to avoid the possible bias induced by reverse causality. For example, happy people may want to share their feelings or information about positive life events on SNS with their important persons. On the other hand, lonely and/or unhappy individuals may want to use SNS with the hope of improving their condition by establishing new relationships and sharing their feelings.

To deal with this possibility, we turn to instrumental variables estimates using two stage least squares (TSLS) where, in the first stage, we instrument our measure of SNS use.

We adopt two instruments that we believe are exogenous to subjective well-being – orthogonality condition – and not driven by individuals' propensity for SNS use – relevance condition:

1. The share of the population for whom a DSL connection was available in respondents' region of residence. DSL ("digital subscriber line", originally "digital subscriber loop") is a family of technologies that offers access to the Internet by exchanging digital data over the wires of a telephone network. Data are retrieved from the Italian Ministry of Economic Development.
2. The percentage of the region's area that is not covered by optical fibre, which represents a measure of digital divide. Optical fibre allows exchange of information over long distances and at higher bandwidths than DSL. Data are based on figures from the Italian Observatory on Broadband.

Both instruments were observed in 2008 and measured at the regional level two years before MHS data were collected. The availability of DSL is a pre-condition for the individual choice to purchase a high-speed access that may create room for the development of online interactions, which in turn may influence individual welfare in a variety of ways.

Our assumption that the differences in the availability of DSL are exogenous to subjective well-being derives from the environmental features of the Italian territory, which have played (and currently play) a major role in the development of Italy's infrastructures for accessing fast Internet. DSL technology is based on the transmission of data over the user's copper telephone line, i.e. over pre-existing voice telecommunications infrastructures. However, the availability of a telephone infrastructure is a necessary, but not sufficient condition for the availability of broadband. What really matters is the so-called "local loop", i.e. the distance between final users' telephone line and the closest telecommunication exchange or "central office" (Grubesic, 2008; Czernich, 2012). The length of this distance does not affect the quality of the connection for traditional voice services. This is why, before the advent of the Internet, the former state monopoly phone carrier (*Telecom Italia*) did not pay any attention to the length of local loops, which was entirely determined in accordance to the orographic features of the territory. However, this distance matters for the provision of fast Internet because the longer is the copper wire, the less bandwidth is available via this wire. In particular, if the distance is beyond a threshold of approximately 4.2 kilometres (about 2.61 miles), then the band of the copper wires is not wide enough to allow a fast Internet connection (Grubesic, 2008; Czernich, 2012). This happens, for example, in most Italian rural areas, which represent more than half of the Italian territory. In 2007, a large part of these areas were characterized by a high length (≥ 4.2 kilometres) of local loops, which ultimately is the result of the imperviousness of the territory. Therefore, in most cases, these areas lacked the necessary infrastructures for the diffusion of the DSL broadband (Ciapanna and Sabbatini, 2008; Agcom, 2011). Since our data do not allow to measure the length of the local loops, we

build our instrument as the DSL coverage at the regional level, which depends on the regional structure of local loops.[1]

We find reasonable to assume that subjective well-being in 2010, 2011, and 2012 is not directly correlated with the distribution of DSL infrastructures in 2008 because this instrument strictly depends on local loops, whose location and length were determined by the orographic features of the territory before the rise of the Internet.

The arguments supporting the assumption of the orthogonality of the share of the population covered by DSL are even more compelling for the second instrument. When the broadband connection cannot be implemented through pre-existing copper wires, it is necessary to turn to an optical fibre-based technology. The possibility and the costs of installing this type of infrastructure, however, strongly rely on the exogenous characteristics of the natural environment. Differently from DSL, in fact, optical fibre entails the installation of new underground cables. This involves excavation works, which are expensive and generally delay or even prohibit the provision of broadband in the area. Hence, orographic differences can be considered as a "natural" cause of the digital divide. The latter generated a variation in access to fast Internet across regions that is exogenous to people's well-being and cannot be driven by their preference for SNS use. The assumption of orthogonality of the instruments is supported by the tests of over-identifying restrictions we run in the context of IV estimates (reported in Section IV).

For any given set of orographic characteristics of the area, the provision of broadband – whether through DSL or optical fibre technology – may also have been influenced by some socio-demographic factors that affected the expected commercial return on the provider's investment, such as population density, per capita income, the median level of education and the local endowments of social capital. To account for the eventual confounding effects of these features, we included regional GDP per capita in real euros of 2005, the regional level of social trust, and of frequency of meetings with friends along with a set of regional and year dummy variables.

We run a 2SLS model: in the first step, the use of SNS is regressed over the two instruments and the control variables. In the second step, life satisfaction is regressed over the complete list of variables presented above.

Formally, the first stage can be written as:

$$SNS_i = \pi_1 + \pi_2 \cdot z_1 + \pi_3 \cdot z_2 + \pi 4 \cdot \mathrm{X_i} + \boldsymbol{\delta} \cdot \boldsymbol{Reg_j} + v_i \qquad (2)$$

where i and j indicate the individual and regional observations respectively, v_i is

1. Figure S1 in the SI presents a map of the broadband coverage of the Italian territory, in comparison with its orographic characteristics.

the error term, z_1 and z_2 are the two above-mentioned instruments, X_i is a vector of control variables, π_1, π_2, π_3, and π_4 are the coefficients to be estimated, $\boldsymbol{Reg_j}$ is the vector of regional level control variables including real regional GDP per capita, the regional level of social trust, and of frequency of meetings with friends, and $\boldsymbol{\delta}$ is the respective vector of coefficients.

The second step is as follows:

$$SWB_i = \alpha + \beta_1 \cdot friends_i + \beta_2 \cdot trust_i + \beta_3 \cdot \widehat{SNS_i} + \theta \cdot X_i + \boldsymbol{\delta} \cdot \boldsymbol{Reg_j} + \epsilon_i \quad (3)$$

where i and *j* indicate the individual and regional observations respectively, *SWB* is life satisfaction, *friends* is the frequency of meetings with friends, *trust* indicates social trust, $\widehat{SNS_i}$ is the SNS use predicted in the first stage, α, β_1, β_2, β_3 are the coefficients of the constant term, and of the three variables of interest, while θ is the vector of coefficients for the remaining control variables, and ϵ_i is the error term. In all our regressions we use robust standard errors to control for heteroskedasticity.

Finally, to test for possible indirect effects of SNS use on subjective well-being mediated by social trust and face-to-face interactions, we adopted a structural equations model, which allows to account for the mediating effects and for possible latent confounding variables (Kupek, 2006).

We follow the conventional practice of indicating endogenous variables with η and exogenous variables with ξ. Error terms are indicated with the symbol ξ. In the model with the best goodness of fit, subjective well-being, η_1, is influenced by social trust, η_2, face-to-face interactions, η_3, and the use of SNS, η_4:

$$\eta_1 = \beta_{12}\eta_2 + \beta_{13}\eta_3 + \beta_{14}\eta_4 + \zeta_1 \quad (4)$$

Social trust is influenced by the use of SNS and by possible confounding factors also influencing face-to-face interactions:

$$\eta_2 = \beta_{24}\eta_4 + \zeta_2 \quad (5)$$

The same holds for face-to-face interactions:

$$\eta_3 = \beta_{34}\eta_4 + \zeta_3 \quad (6)$$

The use of SNS is influenced by our instruments, i.e. broadband coverage in terms of DSL (ξ_1) and fiber (ξ_2):

$$\eta_4 = \gamma_{41}\xi_1 + \gamma_{42}\xi_2 + \zeta_4 \tag{7}$$

The assumption of the simultaneous influence of omitted variables on both social trust and face-to-face interactions means that errors (ξ_2) and (ξ_3) are correlated and the need to estimate the covariance ψ_{32} between the errors, in addition to β parameters. The model can be described in a reduced form as:

$$\begin{bmatrix}\eta_1\\ \eta_2\\ \eta_3\\ \eta_4\end{bmatrix} = \begin{bmatrix}0 & \beta_{12} & \beta_{13} & \beta_{14}\\ 0 & 0 & 0 & \beta_{24}\\ 0 & 0 & 0 & \beta_{34}\\ 0 & 0 & 0 & 0\end{bmatrix} \cdot \begin{bmatrix}\eta_1\\ \eta_2\\ \eta_3\\ \eta_4\end{bmatrix} + \begin{bmatrix}0 & 0\\ 0 & 0\\ 0 & 0\\ \gamma_{41} & \gamma_{42}\end{bmatrix} \cdot \begin{bmatrix}\xi_1\\ \xi_2\end{bmatrix} + \begin{bmatrix}\zeta_1\\ \zeta_2\\ \zeta_3\\ \zeta_4\end{bmatrix}, \quad \begin{bmatrix}0 & 0 & 0 & 0\\ 0 & 0 & \psi_{23} & 0\\ 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0\end{bmatrix} \tag{8}$$

Following path analysis symbology, model (8) is presented in Figure S2 in the Supporting Information (hereinafter SI).

V. PARTIAL CORRELATIONS USING OLS

Table 2 shows the results of the OLS analysis[2]. Control variables are included incrementally to check the robustness of the results. The first column reports the results of life satisfaction regressed over the set of socio-demographic control variables, including the devices used to connect to the Internet. As expected, the kind of connection (e.g. modem, DSL, fibre, satellite, etc.) does not have any statistically significant relationship with life satisfaction. In models 2 and 3 we add the controls for social capital: the former shows the results when trust in others is measured by social trust, while in the latter we include the wallet question. In both specifications the proxies of social capital are significantly and positively correlated with life satisfaction. This result is consistent with previous literature examining the role of relational goods in individual happiness (Becchetti et al., 2008; Sarracino, 2016; Bartolini et al., 2013; Bartolini and Sarracino, 2015).

2. Socio-demographic control variables, year and region dummies are omitted for brevity. For more details please refer to Table S1 in the SI.

Table 2

Relationship between use of SNS and life satisfaction. OLS estimates with robust standard errors. Control variables are included step-wise in the model. Models 7 and 8 present the results from the complete equations.

Variables	model 1	model 2	model 3	model 4	model 5	model 6	model 7	model 8
	Basic controls	Social trust	Wallet question	SNS	SNS + Social trust	SNS + Wallet question	SNS + Social trust + Regional controls	SNS + Wallet question + Regional controls
modem	0.079	0.082	0.0747	0.064	0.0671	0.0615	0.0679	0.0621
	-1.07	-1.11	-1.01	-0.86	-0.91	-0.83	-0.92	-0.84
dsl	-0.00495	-0.00632	-0.0108	-0.0099	-0.0133	-0.017	-0.0105	-0.0144
	(-0.07)	(-0.10)	(-0.16)	(-0.15)	(-0.20)	(-0.26)	(-0.16)	(-0.22)
fiber	0.0403	0.028	0.0267	0.0352	0.0251	0.0257	0.0208	0.0209
	-0.43	-0.3	-0.29	-0.37	-0.27	-0.28	-0.22	-0.22
satellite	0.0525	0.041	0.0408	0.0464	0.036	0.0371	0.04	0.041
	-0.71	-0.56	-0.56	-0.63	-0.49	-0.5	-0.55	-0.56
3G	0.0206	0.0178	0.012	0.0185	0.0154	0.0101	0.02	0.0146
	-0.23	-0.2	-0.14	-0.21	-0.18	-0.12	-0.23	-0.17
USB	-0.00863	-0.0111	-0.0114	-0.0154	-0.0174	-0.0197	-0.0163	-0.0187
	(-0.12)	(-0.16)	(-0.16)	(-0.22)	(-0.25)	(-0.28)	(-0.23)	(-0.27)
frequency of meetings with friends		0.0744***	0.0801***		0.0778***	0.0833***	0.0783***	0.0838***
		-7.21	-7.73		-7.54	-8.03	-7.59	-8.08
social trust		0.313***			0.313***		0.312***	
		-14.73			-14.74		-14.7	
social trust (wallet question)			0.138***			0.137***		0.136***
			-9.24			-9.18		-9.13
SNS				-0.0761***	-0.0949***	-0.0856***	-0.0933***	-0.0840***
				(-3.34)	(-4.18)	(-3.76)	(-4.12)	(-3.69)
social trust (by region)							-0.968	-1.249
							(-1.12)	(-1.44)
frequency of meeting friends (by region)							-0.466*	-0.461*
							(-1.99)	(-1.96)
							-0.250**	-0.249**

(Continues)

Table 2. (Continued)

Variables	model 1	model 2	model 3	model 4	model 5	model 6	model 7	model 8
	Basic controls	Social trust	Wallet question	SNS	SNS + Social trust	SNS + Wallet question	SNS + Social trust + Regional controls	SNS + Wallet question + Regional controls
real GDP per capita (thousands € 2005)							(-2.76)	(-2.75)
Constant	8.816***	8.299***	8.135***	8.889***	8.346***	8.179***	17.87***	17.88***
	-23.62	-22.57	-20.91	-23.79	-22.71	-21.05	-7.08	-7.05
Observations	24582	24505	24505	24505	24581	24582	24581	24582
Adjusted R squared	0.025	0.039	0.034	0.025	0.04	0.034	0.04	0.035

Note: t-statistics in parenthesis;
*p < 0.1;
**p < 0.01;
***p < 0.001.
Socio-demographic control variables, year and region dummies are omitted for brevity. For more details please refer to Table S1 in the SI.

The significant and positive coefficient of social trust, on the other hand, is consistent with empirical studies claiming the existence of a link between various forms of trust and life satisfaction across countries (Bjørnskov, 2003) and at individual level (Helliwell, 2003; Helliwell et al., 2009; Helliwell and Wang, 2011).

Models 4 to 6 include our main explanatory variable, i.e. the use of online social networks, along with the controls for trust in others (model 5 for social trust, and model 6 for the wallet question). Results show a significant and negative correlation between the use of SNS and subjective well-being which is independent from the controls for social capital. The same result is confirmed in models 7 and 8 which report the results for the full model in which we also include the regional level control variables, namely regional GDP per capita, and the regional level of social trust, and of frequency of meetings with friends. In other words, our results indicate that, ceteris paribus, the use of SNS is negatively and significantly correlated with people's life satisfaction. This result must be handled with caution due to the sources of potential endogeneity we described in the previous sections. To address this issue, we turn to the 2SLS strategy described in section IV.1.

VI. INSTRUMENTING THE USE OF SNS

Our IV approach uses the percentage of the population for whom DSL connection was available in respondents' area of residence in 2008 and the percentage of the region's area that was not covered by optical fibre in 2008 as instruments to predict the use of SNS in the period 2010-2012. Results are presented in table 3: the first two columns report the first and second stage regressions when we control for social trust, while the last two columns provide the same information when trust in others is measured with the wallet question[3].

The two sets of regressions provide consistent results. The instruments are significantly associated with the use of SNS in the first stage equations, thus providing some empirical support to our argument on the exclusion restriction. Additionally, the tests of overidentification report coefficients close to 10, which practitioners regard as a safe threshold to exclude the possibility of weak instruments.

In both second stage regressions the proxies of social capital are positively and significantly associated with life satisfaction, while the use of SNS has negative and significant coefficients. The other control variables keep their signs unchanged. In particular, the relationship between age and well-being is U-shaped, being single or widowed compared to being married significantly

3. Socio-demographic control variables and region dummies are omitted for brevity. For more details please refer to Table 2 in the SI.

Table 3

Two-Stages Least Squares estimates of the use of SNS on life satisfaction. The first two columns provide the first and second stage results when we use social trust as a proxy of trust in others. The last two columns provide the same information when we use the wallet question.

	First stage		Second stage		First stage		Second stage	
Dependent variables:	SNS		Life satisfaction		SNS		Life satisfaction	
Variables:	Equations with social trust				Equations with wallet question			
optic fiber (%)	0.00138**	-2.21			0.00131**	-2.1		
broadband coverage (%)	0.00322***	-4.58			0.00309***	-4.39		
frequency of meetings with friends	0.0300***	-9.43	0.150***	-5.28	0.0306***	-9.63	0.148***	-5.16
social trust	0.0147*	-1.95	0.348***	-11.51				
year==2011	0.0362***	-5.14	0.103**	-2.54	0.0357***	-5.07	0.0912**	-2.32
year==2012	-0.00958	(-0.80)	-0.202***	(-4.32)	-0.00853	(-0.71)	-0.208***	(-4.65)
modem	-0.137***	(-4.81)	-0.342*	(-1.95)	-0.139***	(-4.85)	-0.302*	(-1.73)
dsl	-0.0333	(-1.26)	-0.17	(-1.62)	-0.0345	(-1.30)	-0.157	(-1.54)
satellite	-0.0261	(-0.92)	-0.102	(-0.94)	-0.0263	(-0.93)	-0.0839	(-0.80)
3G	0.00938	-0.29	-0.0409	(-0.35)	0.00901	-0.27	-0.0391	(-0.35)
USB	-0.0610**	(-2.23)	-0.241**	(-1.97)	-0.0623**	(-2.27)	-0.216*	(-1.80)
mobile	0.0343	-1			0.0335	-0.98		
social trust (by region)	0.219**	-2.34	-1.419***	(-3.30)	0.185**	-1.99	-1.641***	(-4.09)
frequency of meeting friends (by region)	-0.0236	(-0.63)	-0.128	(-0.89)	-0.0265	(-0.71)	-0.135	(-0.97)
real GDP per capita (thousands € 2005)	0.0000982	-0.07	-0.0182***	(-3.68)	0.000109	-0.08	-0.0184***	(-3.87)
SNS			-2.470**	(-2.92)			-2.185**	(-2.57)
social trust (wallet question)					-0.0138**	(-2.97)	0.110***	-5.02
Constant	0.133	-0.49	11.93***	-10.76	0.206	-0.76	11.83***	-10.68
Observations	24505		24505		24505		24505	
R-squared	0.195				0.195			
Test of overidentification			10.504				9.622	

Note: t-statistics in parenthesis;
*p < 0.1;
**p < 0.01;
***p < 0.001.
Socio-demographic control variables, and region dummies are omitted for brevity. For more details please refer to Table S1 in the SI.

correlates with lower life satisfaction, and the higher the education level, the higher is life satisfaction. The dummies indicating the device used to connect to the Internet are not significantly associated with life satisfaction, except the dummies for modem and USB. The use of the latter two devices is negatively and significantly associated with life satisfaction. Finally, among regional level control variables, only the regional share of social trust and the real GDP per capita retain some significant association with life satisfaction. In sum, our results suggest that the negative association between the use of SNS and life satisfaction identified in the OLS is robust to possible endogeneity issues. This indicates that the use of SNS directly reduces people's well-being. Can it also have an indirect effect mediated by the relationship between SNS use and our proxies of social capital? We address this issue in the next section.

VII. THE INDIRECT EFFECT OF SNS ON WELL-BEING

In order to disentangle the direct and indirect drivers of the partial correlation between SNS use and subjective well-being found in OLS estimates, we estimated the structural equation model described in Section IV.1.

In this model, we simultaneously estimate the effect of the use of SNS on subjective well-being, on social trust, and on the frequency of meetings with friends jointly with the effect of the latter two on subjective well-being. This empirical strategy allows us to disentangle the direct effect of the use of SNS on life satisfaction, from the indirect one mediated by its relationship with trust in others and offline interactions. Results are reported in table 4 and they are presented graphically in figure 1.

Modification indexes take all values lower than 3.84, thus confirming the goodness of the model. The estimates suggest that SNS use is associated with a reduction in trust in others and with an increase in the frequency of meetings with friends. Both social trust and the frequency of meetings with friends are in turn strongly and positively correlated with subjective well-being.

Goodness of fit measures are reported at the bottom of Table 4. Since the model chi-square is affected by sample size, following Kline (2005), we divide its value by the degrees of freedom of the model, obtaining the Normed Chi Square (NC). In general, as the sample size gets larger, the reliability of overall fit measures is reduced. In addition, it must be noted that values of fit indexes only indicate the average or overall fit of a model, and that it is possible that some parts of the model poorly fit the data even if the value of a particular index seems favourable (Kline, 2005). It thus seems reasonable to focus on the significance of estimates' coefficients, which are reported in Figure 1 for ease of illustration.

Table 4

Indirect effects of the use of SNS on life satisfaction using SEM (standardized variables).

Variables	Coefficients	Std. Err.
frequency of meetings with friends		
SNS	0.208***	40.70
Constant	0.172***	33.38
life satisfaction		
frequency of meetings with friends	0.0657***	10.50
social trust	0.0792***	17.33
SNS	-0.0240***	4.64
Constant	0.219***	42.10
social trust		
SNS	-0.0406***	5.79
Constant	0.179***	25.41
SNS		
optic fiber (%)	0.0438***	6.38
broadband coverage	0.0389***	5.15
Constant	0.0681	10.56
var(freq. of meetings with friends)	0.646***	110.69
var(life satisfaction)	0.619***	110.69
var(social trust)	1.210***	110.69
var(SNS)	1.004***	110.69
cov(freq. of meetings with friends, social trust)	0.00584	1.03
Observations	24505	
Indexes of Goodness of fit		
Chi-squared	(model vs. saturated)	174.32***
Size of residuals	SRMR	0.024
Baseline comparison		
CFI	0.863	Comparative Fit Index
TLI	0.679	Tucker-Lewis Index

Note: t-statistics in parenthesis;
*p < 0.1;
**p < 0.01;
***p < 0.001.

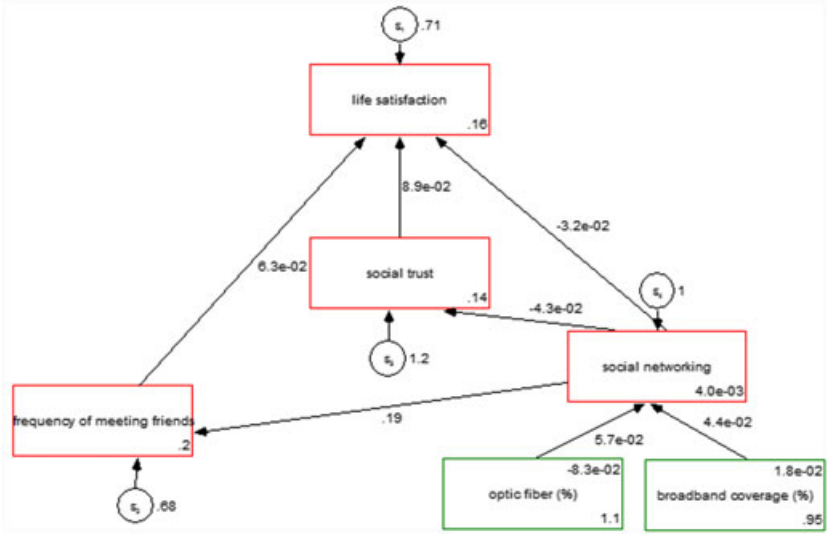
The SEM analysis suggests that the significantly negative correlation between SNS use and subjective well-being obtained in OLS estimates is not only the result of a direct negative effect, but it also results from the combination of two indirect channels:

1. the negative correlation between the use of SNS and social trust that negatively affects well-being.
2. the positive correlation between the use of SNS and face-to-face interactions that positively affects well-being.

The positive correlation between the use of SNS and face-to-face interactions is consistent with previous findings from economics and computer science. SNS play a positive role in helping Internet users to preserve their face-to-face

Figure 1

Direct and indirect effects of the use of SNS on subjective well-being. Coefficients refer to standardized variables with mean = 0 and standard deviation = 1, and they can be interpreted as the expected change associated with a one standard deviation increase in the use of SNS. For instance, a one standard deviation increase in the use of SNS decreases life satisfaction by -0.031 points, social trust by -0.042, and increases the frequency of meetings with friends by 0.19 points. [Colour figure can be viewed at wileyonlinelibrary.com]



relationships against the threats posed by busyness and distance (Helliwell and Huang, 2013; Antoci et al., 2015).

The negative relationship of SNS use with social trust, on the other hand, partly contradicts previous literature on the topic. This may be due to the fact that empirical studies finding positive effects of Facebook use on trust in others drew on limited samples, in most cases composed of small communities of undergraduate students enrolled in specific American colleges (see for example Ellison et al., 2007; Steinfield et al., 2008; Valenzuela et al., 2009), whose members may be characterized by a limited radius of trust (Delhey et al., 2011).

As reported in Section III, the early psychological literature in computer-mediated communication and some recent economic studies have suggested some reasons for which the use of SNS may expose individuals to the negative externalities produced by other users. Specifically, the experience of online incivility may deteriorate users' trust in others with detrimental consequences for their subjective well-being.

The total indirect effect of the use of SNS on well-being is slightly positive: a one standard deviation increase in the use of SNS is associated to a net increase of life satisfaction of 0.0104 points on a scale from 1 to 10, i.e. about 1%. This figure is the result of the indirect effect of the use of SNS on social trust -- the increase of the use of SNS by one standard deviation reduces life satisfaction by -0.32% -- and on the frequency of meetings with friends: one standard deviation increase in SNS use is associated with 1.36% increase in life satisfaction. Finally, the total negative effect of a one standard deviation increase in the use of SNS on life satisfaction is -1.36%. In sum, besides a negative direct impact, the use of SNS affects life satisfaction also indirectly, through its side effects on social trust and the frequency of meetings with friends. The latter accounts for about 70% of the total indirect effect, while social trust accounts for the remaining 30%. Hence, the total indirect effect of the use of SNS for well-being is positive, but not large enough to compensate for the negative indirect effect mediated by social trust and for the direct effect of the use of SNS on well-being.

VIII. CONCLUSIONS

In this paper we empirically analysed the relationship between the use of SNS and subjective well-being in a large and nationally representative sample provided by the Italian National Institute of Statistics. The analysis shows that SNS use has a negative and significant correlation with life satisfaction. This result is based on Ordinary Least Squares estimates with robust standard errors accounting for a set of individual and regional level control variables. We addressed endogeneity in individuals' propensity for SNS use by exploiting regional differences in fast Internet accessibility caused by the characteristics of the pre-existing voice telephony network that exogenously determined the availability of broadband. The results from Two-Stages Least Squares show that our results from OLS are robust to possible endogeneity issues. Additionally, to disentangle the direct effect of SNS use from the change in well-being that may be caused by SNS impact on trust and meeting friends, we turned to a structural equation model. Results suggest that, besides the direct effect of SNS on well-being, such relationship is also mediated by two indirect effects: the positive impact on face-to-face social interactions and the negative impact on social trust.

People choose to join networks because they want to enjoy the benefits of being connected with others. Online social networks provide an answer to this need. Yet, their use may entail relevant negative externalities.

There are several reasons to treat these findings with caution. The causal interpretation of the estimates from pooled cross-sectional data requires prudence. The Multipurpose Survey on Household (MHS) lacks information

about how much time users spend on SNS and which kind of activities they carry out online. In MHS data it is not possible to distinguish between Facebook and Twitter, and there is no information to control for relevant characteristics of the user's area of residence, such as the population size and the closeness to an urban center. We do not know neither if respondents encountered aggressive behaviors online, nor if they were targeted with hate speech. In case of low exposure to online diversity, it may be possible that SNS use actually dismantles people's beliefs and expectations about the others, with negative consequences for their social trust, and their well-being. In addition, it is impossible to test whether SNS use is associated with forms of addiction or other mental disorders. Even if we believe that the instruments we used to tackle endogeneity are valid, longitudinal data could help to better identify the effect of online networks on subjective well-being, while more comprehensive information about how individuals use online networks could help to interpret the possible transmission mechanisms. In addition, broadband coverage could be a proxy for closeness to an urban center that might well directly affect SWB as well as the use of SNS, but our data do not allow controlling for this aspect in regressions.

The SEM analysis allows a refinement in our hypotheses about the relationship between the use of SNS and subjective well-being by highlighting the possibly mediating roles of social trust and face-to-face interactions. However we emphasize that, as other unexamined models may fit the data as well or better, an accepted model should be considered only as a "not-disconfirmed" model. At this stage, the problem of causality still remains open to question and the endogeneity problems we described in Section IV.1 are not definitively solved.

Despite these limitations, our study contributes to the literature in several ways. Previous studies on the social consequences of the Internet analysed the relationship between broadband availability and a range of supposed outcomes without investigating the type of use that individuals make of the broadband. Our study, by contrast, focuses on a specific use of the broadband, participation in social networking sites, to analyse how it correlates with subjective well-being in a large, nationally and regionally representative sample. In addition, we try to disentangle the influence of possibly confounding factors and to deepen our understanding of how SNS may affect individual welfare by focusing on the possibly mediating role of two relevant dimensions of social capital. The theoretical arguments and the findings presented in this study highlight the need to focus future research on a problem that has so far been neglected, i.e. the possibility that SNS use may worsen social trust and well-being, and to give more attention to the issue of the Internet regulation, especially with regard to social interaction in online networks.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's website.

SUMMARY

We test the relationship between the use of social networking sites (SNS) and a proxy of utility, i.e. subjective well-being (SWB), using instrumental variables. Additionally, we disentangle the indirect effects of SNS on well-being mediated by face-to-face interactions and social trust using a structural equation model. Results suggest that the use of SNS hampers people's well-being directly and indirectly, through its negative effects on social trust. However, the use of SNS also has a positive impact on well-being because it increases the probability of face-to-face interactions. Yet, the net effect of the use of SNS for SWB remains negative.