



Does Social Media Penetration Enhance Democratic Institutions? Evidence from Varieties of Democracy Data

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Abstract

We examine whether social media enhances democracy using cross-sectional data from 145 countries. We used Facebook penetration as a proxy for social media. Also, based on the complex definition of democracy, high-level indices, such as egalitarian, participatory, liberal, electoral, and deliberative democracies, were used to capture democracy. Our endogeneity-corrected results documented that high social media penetration, on average, enhances all forms of democracy. In descending order, social media penetration has contributed more to enhancing democracy in high-income economies, followed by lower-middle and upper-middle income economies. In low-income economies, social media penetration has a negative effect on democracy indices. We also documented heterogeneity in the findings based on regions. Marginal analysis also revealed that the positive effect of social media on democracy is higher in countries with higher internet penetration. We suggest that with appropriate interventions, policymakers could leverage social media to enhance democratic institutions.

Keywords Democracy · Facebook · Political institutions · Social media

1 Introduction

Historical perspectives on the drivers of democracy often concerned themselves with factors such as the level of national wealth, state of economic condition, depth of natural capital, level of education, degree of globalization, and rate of urbanization (Acemoglu & Robinson, 2005; Barro, 1999; Huntington, 1984; Lerner, 1958; Lipset, 1959; Przeworski & Limongi, 1997). Others pointed to the relevance of cultural prerequisites necessary for the emergence of a “democratic personality,” a “modern” personality, or a “civic culture”

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essential to the proliferation of democratic values, beliefs, and norms (Almond & Verba, 1963; Arat, 1988; Putnam et al., 1994). Though the mass media was often not the central mechanism embedded within these theories, Lerner (1958) pointed to the potential role of the media as a multiplier of the modernization process through which democracies emerge. In line with this literature, the current study examines the impact of social media on democracy against the backdrop of the recent mass proliferation of digital and social media over the past two decades. In fact, by April 2023, nearly five billion people had logged on to various social media platforms, representing approximately 60% of the global population. By 2027, over 70% of the world is expected to be connected through various social media platforms (Ruby, 2023). While Facebook currently accounts for more than half of all global social media users, other platforms such as Tiktok, Twitter, Twitch, Mastodon, Clubhouse, and the recently launched Threads are growing at exponential rates and attracting more and more people into a new global reality.

Indeed, this rapid growth of social media has attracted questions regarding its impact on democracy. On the one hand, a cadre of digital optimists contends that social media penetration would have a net positive impact on democracy by, among other mechanisms, lowering costs associated with political engagement, eliminating the information asymmetry between citizens and their political representatives, and empowering the voiceless in society. In line with these optimistic expectations, researchers have recorded extensive evidence of increased political participation across multiple countries. Activities such as participation in protests, engagement in political discourses, and donations to political causes have all risen thanks to the increasing use of social media (Lorenz-Spreen et al., 2023). Others have shown that by using aggregate democratic indices, social media strengthens democratic variables around the world (Jha & Kodila-Tedika, 2020).

On the other hand, a counterbalancing perspective by a cadre of cyber-pessimists asserts that social media usage would have a detrimental effect on democracy. Social media penetration, they contend, empowers anti-democratic adversarial actors and helps connect fringe voices with disruptive intentions that foster hate, misinformation, and disinformation to undermine trust in democratic institutions. Digital pessimists also argue that social media persists in sorting the mass public into ideological echo chambers that encourage rejection of opposing views, deter political collaboration, and distort a shared sense of reality. In line with these pessimistic expectations, other researchers have shown that social media usage has been central to the rise of populist movements such as those that propelled the 2016 election of Donald Trump, the *Brexit* vote in the UK, and the eventual attack on the US Capitol on January 6, 2021, that threatened the foundations of the American democracy (Lorenz-Spreen et al., 2023; Olaniran & Williams, 2020). The extant literature has also disclosed that the growth of social media is closely associated with declining trust in democratic institutions, faltering quality of political discourse, and rising polarization among fellow citizens (Lorenz-Spreen et al., 2023; Persily & Tucker, 2020).

However, in spite of these instructive insights into the relationship between social media usage and democracy, the discourse is yet to benefit from a holistic analysis of the impact of social media on different forms of democracy across the world. That is, does social media penetration impact all democracies equally? Patently, different democratic systems or principles may be fashioned on different institutional setups, offering different levels and forms of political participation or reflecting different societal objectives. Taking the Varieties of Democracy (V-DEM) classification of democracies into consideration, for example, a democracy built dominantly on participatory principles might offer opportunities for participation vastly different from one built dominantly on egalitarian or liberal principles (Coppedge et al., 2011, 2018). For this reason, there is reason to believe that the impact of

social media on democracy will depend significantly on the type of democracy in question. Therefore, this study aims to investigate social media's impact on democracy across 145 countries.

The study's novelty and contributions to the literature on the political implications of social media are discussed as follows. First, studies analyzing the relationship between social media and democracy across countries have relied on cross-country measures of democracy proffered by sources such as the Freedom House Index, Eurobarometer, Congressional Cooperative Election Study (CCES), and other regional surveys (See: Placek, 2018; Lelkes, 2020; Jha & Kodila-Tedika, 2020). However, a fundamental challenge of these measures is their inadequacy in "measuring small changes and differences in the quality of autocracy/democracy; empirically analyzing relationships among various elements of democracy; and evaluating the effectiveness of targeted democracy promotion efforts" (Coppedge et al., 2011, p. 252). Coppedge et al., (2011, 2018) also decry the validity, reliability, aggregation, coding, sources, and coverage of these existing measures, disclosing that the indices from these sources are "narrow" as they often only reflect the existence of elections. They stress that democracy transcends the mere presence of elections and that reliance on aggregate measures of democracy might conceal small but relevant changes happening within the sample. Thus, to draw more valid conclusions and offer more reliable policy recommendations, there is a need to seek more precise democracy indices. This paper, thus, addresses this gap by being the first to comprehensively analyze the impact of social media on different forms of democracy, recognizing that democracy is a complex concept with multiple dimensions. In line with the political science literature, our study adopts five high-level democracy indices: electoral, liberal, participatory, deliberative, and egalitarian democracy, as proposed by Coppedge et al. (2018). These democracy indicators offer a novel approach to comprehending and measuring democracy, providing a comprehensive and detailed dataset that goes beyond the simplistic notion of democracy merely involving elections. The approach contributes to the existing literature and provokes a new perspective crucial to a more contextualized yet simplified understanding of the relationship between social media and democracy.

Second, social media penetration and usage, as well as democracy, are not homogenous across the globe and differ among geographical regions. This study, therefore, contributes to the literature by probing further if the impact of social media on democracy differs across geographical regions and countries at different stages of economic development. Our empirical results supported this claim and highlighted that in low-income economies, social media penetration has a negative effect on egalitarian, participatory, liberal, electoral, and deliberative democracies. On the other hand, social media penetration significantly improves egalitarian, participatory, liberal, electoral, and deliberative democracies in lower-middle, upper-middle, and high-income economies. The findings also indicate that the effect of social media on democracy differs among regions with a significant and positive impact when restricting our study sample to only East Asia & Pacific, America¹ and MENA countries. However, the findings showed that social media is not a significant determinant of democracy when we restrict the study sample to only sub-Saharan Africa, South Africa, Europe, and Central Asia countries.

Third, unlike previous studies such as Jha and Kodila-Tedika (2020), this study examines if the impact of social media on democracy depends on internet penetration. We argue

¹ America used in this study includes Canada and Latin America & Caribbean countries.

that social media is a complementary good and that the ability of social media to function effectively depends on other goods, such as internet access. For instance, one cannot effectively log on to facebook without the internet. Our empirical results revealed that the effect of social media on democracy is conditional upon internet penetration. Thus, results confirm that for social media (Facebook) to enhance democracy, there should be higher internet penetration. Therefore, in countries with poor internet access, social media would not enhance democracy and vice versa.

Methodologically, this study relies on the Lewbel two-stage least square estimator to address endogeneity. This external instrument-free estimator constructs its internal heteroskedasticity-based instrument from the auxiliary equation residuals, which is then multiplied by each of the included exogenous variables in a mean-centred form (Lewbel, 2012). We also adopted Machado and Silva's (2019) method of moment quantile regression (MMQR) technique, which accounts for distributional heterogeneity and fixed effects, to test for the robustness of the effect of social media on the distribution of democracy variables. Finally, we adopted Young and Holsteen's (2017) analytical approach to evaluate the uncertainty in our model specification and the robustness of the effect of social media on the democracy variables.

The findings from this study would have significant implications for policy. The concerns about the impact of social media usage on democracy are at their highest. Lawmakers in the US and other countries are currently debating bills on platform accountability and transparency to ensure that social media, which has become the de facto public town square, safeguards a healthy and inclusive environment for political debate (Gallo & Cho, 2021). Steps are also being taken in countries such as Mexico, Ecuador, Finland, Sweden, Norway, and several other parts of the world to introduce programs to improve citizens' media and digital literacy to guard against the spectre of disinformation and misinformation (Barredo-Ibáñez et al., 2023; Erstad et al., 2021). The effectiveness of the eventual regulations and programs would depend significantly on a comprehensive understanding of the impact of social media on various principles and forms of democracy. Further, the knowledge from this study should guide governments and civil society groups to better design policies addressing social media usage's specific impacts on specific aspects of their democracy.

For the remainder of the paper, we review the literature on the relationship between social media and democracy, describe the methodology, discuss the results, and conclude.

2 Review of Related Literature

The relationship between social media and democracy might draw some of its theoretical roots from the early conceptions of modernization theory. Lerner (1958) was among some of the first to draw parallels between mass media and certain drivers of democracy by asserting that mass communication might enhance the modernization process that facilitates democratic transitions through education and rapid information dissemination. Lipset (1959) clarified the modernization theory as the likelihood of societies experiencing democratic transitions as they industrialize, urbanize, and experience rising levels of education. The social prerequisites of this transition are underpinned by widespread literacy and education as well as a large and politically active middle class that supports democratic values and institutions. Indeed, several studies continue to report the positive impacts of factors such as education, urbanization, and income on several political outcomes, such

as democracy, the ability to hold leaders accountability, and the desire to vote out non-performing leaders (Barro, 1999; Shah, 2011; Taden et al., 2023). In this context, the mass (social) media then promotes democracy by facilitating the education of citizens and making information available to a larger public.

Indeed, social media has become the leading influencer of democracy and public life, even for people not on social media (Gadjanova et al., 2022; Kamau, 2017). Digital technology and social media have opened communication links between citizens of the same or different countries at a scale not witnessed before. As a natural outcome of its rapid growth, social media has also become a mainstream platform for forming, shaping, and disseminating political messages, raising several critical questions, not the least among which is its impact on democracy. A functional democracy thrives on communication, consensus building, and mass participation. Extant research portends, therefore, that social media might enhance democracy by increasing political participation. Indeed, social media usage has been found to motivate a range of civic behaviours, from low-effort actions such as liking, commenting on, and sharing political messages to high-cost actions such as protesting under repressive governments (Lorenz-Spreen et al., 2023).

Social media has been crucial to the success of protests that generated recent regime and political changes in places such as Sudan and Chile, as well as during the Arab Spring in Tunisia, Libya, Egypt, Yemen, Syria, and Bahrain (Howard & Hussain, 2013; Kadoda & Hale, 2015; Valenzuela et al., 2012). In this vain, social media might speed up democratic transitions by enabling citizens to bypass information barriers established by oppressive regimes. It might also allow more effective political mobilization by connecting fellow citizens with like-minded interests or grievances. Nonetheless, Enikolopov et al. (2020) reveal that while a 10% increase in social media penetration in Russian cities increases the probability of an anti-government protest by 4.6% and the number of protest participants by 19%, it only does so “by reducing the cost of coordination rather than by spreading information critical of the government,” revealing the power of government to control social media content to its repressive advantage. This is synonymous with how repressive governments use social media to control narratives and suppress critical voices during elections (Abrahamsen & Bareebe, 2016; Amoah, 2020). Also, while the literature overwhelmingly demonstrates that social media increases general political participation (Lorenz-Spreen et al., 2023), Lelkes (2020) found that internet usage, unfortunately, does not affect pertinent participatory activities such as voter turnout, and information dissemination might only enlarge the subset of the population disenchanted with politics.

Closely related to the benefit of political participation is the positive impact of social media usage on political engagement. Social media usage might help eliminate the information asymmetry between citizens and their political representatives regarding the latter’s actions, leading to an improved alignment of their interests. For instance, in a study of Twitter usage behaviour among US Congressmen, Mousavi and Gu (2019) discovered that congressmen who use Twitter were more likely to vote in line with the prevailing opinions of their constituents. Additionally, social media usage might help eliminate “class” in favour of equality (Schradie, 2012), ensuring that all or more stakeholders are heard and regarded equally.

Democracy requires trust among fellow citizens as well as trust in political and social institutions such as the judiciary, media, and experts (such as scientists and health departments during health crises). However, social media usage might affect democracy by either negatively or positively impacting trust in these institutions. On the positive domain, Placek (2018) found that social media usage contributes to democratic stability by increasing public trust in the justice system, police, military, and political parties in 11 Central

and Eastern European countries. The author also found that social media usage leads to a higher satisfaction with democracy, a stronger national identity, and a more positive attachment to one's local community. Enikolopov et al. (2020) also show that social media penetration in Russian cities improves support for the national government, as others have shown from samples in Malaysia (Miner, 2015), Kazakhstan (Bekmagambetov et al., 2018), and China (Zhou et al., 2020).

Contrary to these findings, other studies show that social media might decrease support for democracy or government by depleting trust in institutions or weakening community ties. Sabatini and Sarracino (2019) reveal that social media access depletes trust in the Italian police, potentially hampering their ability to uphold the rule of law. Bekmagambetov et al. (2018) also show from a survey of Kazakhstani college students that those "who see, read and share critical information tend to develop distrust in government institutions, which results in an increased proclivity for protest." It's worth noting, however, that a decrease in trust for authoritarian governments due to social media access might inadvertently speed up a transition to democracy. For instance, while internet use in China has been found to exacerbate negative public perceptions about the government and amplify scepticism toward government officials, the scepticism, in turn, intensifies public demand for political participation and elevates the expectation of government performance (Zhou et al., 2020).

Social media has also been found to affect democracy by increasing or decreasing political knowledge, polarization, and populism. For example, a strand of the literature has found that social media usage increases political knowledge and interest, improving the quality of political engagement in the process (Edgerly et al., 2018; Salaudeen & Onyechi, 2020). Improved political knowledge might perfect democracy by enhancing citizens' oversight responsibilities as they are better able to hold leaders accountable. Nevertheless, the news-find-me theory portends that social media usage decreases the quality of knowledge citizens acquire online (Lee, 2020). That is, social media users may no longer actively seek out news as they expect to be presented with it. However, as they wait for news to find them, they may be presented with fake news organized to serve those with neither the interest nor the ability to verify its authenticity. Fake news might undermine democratic stability by distorting shared realities, deepening polarisation, amplifying unfounded rage, and undermining trust in institutions and fellow citizens.

Additionally, adversarial foreign actors might seize opportunities presented by social media to interfere in the internal affairs of a country to achieve geopolitical objectives. For instance, the Russian Internet Research Agency, a "troll factory" set up prior to the 2016 US election and *Brexit* vote in the UK, regularly produced and disseminated pro-Trump and pro-*Brexit* propaganda that contributed to their eventual outcomes (Persily & Tucker, 2020, Chapter 2). In other instances, ghost and foreign social media actors might deploy bots to sow disinformation, misinformation, distrust, and hate among fellow citizens, leading to higher internal agitation (Chibuwe, 2020). Indeed, amid other ambitions, "undermining democracy has been a strategic objective of Russia's," which its government has advanced by using social media to sow dissension and disillusionment in democracy itself while nudging public support for extraconstitutional claims on power in countries such as Mali, Burkina Faso, and Sudan (The Africa Center for Strategic Studies, 2023).

Unsurprisingly, several studies report a detrimental association between social media usage and political polarization in South Korea (Lee et al., 2018), the United States (Bryson, 2020), Germany (Adam et al., 2019), and several other parts of the world (Lorenz-Spreen et al., 2023). In South Korea, for instance, social media users were found to develop more extreme political attitudes than non-users. This is

particularly possible because social media exacerbates the homophily of social and ideological networks as individuals persist in seeking out only those who are similar to them socially and politically, leading to high intolerance for external viewpoints. In Britain and the United States, the excessive polarization of civil society via social-media-created echo chambers and filter bubbles undoubtedly fuelled populist movements that culminated in *Brexit*, the election of Donald Trump, and the eventual attack on the US Capitol that threatened the foundations of the American democracy (Lorenz-Spreen et al., 2023; Olaniran & Williams, 2020). Nevertheless, other studies show that social media usage is associated with an increased diversity of viewpoints and political engagement in Kenya, Nigeria, and the United States (Adegbola & Gearhart, 2019).

Indeed, social media generates varied outcomes for democracy. As surmised from the literature, in some places, the penetration of social media might, for example, improve political participation but simultaneously suppress electoral turnout as voters grow disenchanted with the political class. In other places, the expansion of social media usage might enhance citizens' political knowledge but persist in sorting the public into cantankerous ideological echo chambers, increasing intolerance and deterring political collaboration in the process. The dominant implication from the analysis is that, as different democracies have different institutional setups and varied opportunities for public participation, social media usage might impact different aspects of democracy differently and, more contextually, different democracies differently. Expectantly, the impact of social media usage on electoral democracy, for example, might differ from its impact on deliberative democracy. Commonly, as several countries also have democratic systems built on a combination of different democratic principles, a liberal democracy, for example, might be enhanced by the "class-elimination" dagger of social media usage but simultaneously suffer the irreparable wrath of its institutional-trust-destroying axe.

For this purpose, we turn to the V-DEM classification of democracies—a multi-dimensional and disaggregated classification of the concept of democracy as a system that transcends the mere presence of elections. In line with this classification, we expect that the impact of social media will differ across participatory, liberal, deliberative, egalitarian, and electoral democracies. The V-DEM project describes participatory democracy as one in which citizens get to participate directly in government through local democratic institutions. Liberal democracy prioritizes individual rights and equality before the law. Deliberative democracy gauges the process through which decisions are made in the system and whether dialogue is respectful or coerced. Egalitarian systems are built to neutralize societal imbalances by ensuring equal access to power and resources. Finally, electoral systems focus on making rulers responsive to citizens by ensuring free, fair, and competitive elections. Understandably, the electoral democracy index remains a significant component of all other democracies since there is no democracy without elections (Coppedge et al., 2011, 2018). Inherently, the different democracies or democratic principles strive on different institutional setups, offer varied levels of opportunity for mass participation, and project different societal objectives.

3 Methodology

3.1 Empirical Model and Data

The primary objective of this study is to examine the impact of social media penetration on different forms of democracy across the globe. Consistent with Jha and Kodila-Tedika (2020), this study used cross-sectional data from 145 countries² to estimate the effect of social media on varieties of democracy indices. The reduced-form model for estimation is expressed in Eq. (1).

$$VDEM_i = \alpha_o + \beta_1 \ln SM_i + \sum_{k=1}^N \beta_k X_i + \varepsilon_i \quad (1)$$

where:

- $VDEM_i$ denotes the varieties of democracy variables. As a novelty and contribution to the literature, we deploy five (5) unique democracy indices to capture the different notions of democracy as operationalized in the political science literature (Coppedge et al., 2018). These democracy indices are electoral, liberal, participatory, egalitarian, and deliberative democracy. We extracted the varieties of the democracy indices from the Coppedge et al. (2018) varieties of democracy (V-DEM) database.
- $\ln SM_i$ represents social media penetration expressed in logarithm. Social media penetration is approximated using the number of Facebook users per 100. The Facebook user data was borrowed from Jha and Kodila-Tedika (2020) and Kodila-Tedika (2021), originally developed by Quintly and made publicly available in 2012.³
- X_i is a set of control variables included in the empirical model to address variable omission bias. Following the literature on the determinants of democracy, six (6) key variables. We accounted for the effect of GDP per capita (Barro, 1999; Heo & Tan, 2001; Jha & Kodila-Tedika, 2020). According to the modernization theory propounded by Lipset (1959), GDP per capita plays a very influential role in democratization, and higher economic growth increases democratization. The second variable we controlled in our model is trade openness (Li & Reuveny, 2003). We expect trade openness to have an inverse relationship with democracy. This is because literature indicates that trade openness hinders democracy by widening income inequality and subsequently driving political conflicts (López-Córdova & Meissner, 2008). Another variable included in the empirical model is natural resources rent (Barro, 1999; Brooks & Kurtz, 2016). Natural resource rent is argued to undermine democratic institutions because governments use rents from natural resources to support policies that influence public opinion in favour of the ruling class (Aslaksen, 2010). We also controlled for the effect of internet penetration (Jha & Kodila-Tedika, 2020) and mobile phone penetration (Ben Ali, 2020; Fleming, 2002). Internet and mobile phone penetration are important for enhancing democracy since they enable people to express their opinions and participate in political debates (Weare, 2002). Finally, we accounted for the effect of years of schooling (Barro, 1999; Jha & Kodila-Tedika,

² The study sample is presented in Appendix Table 6.

³ Currently, one needs to purchase the data from Quintly.

Table 1 Descriptive statistics

Variable	Mean	SD	Min	Max
Electoral democracy	0.557	0.256	0.019	0.923
Liberal democracy	0.441	0.268	0.005	0.898
Participatory democracy	0.361	0.207	0.008	0.814
Deliberative democracy	0.455	0.252	0.024	0.885
Egalitarian democracy	0.427	0.244	0.059	0.885
Social media	2.188	1.67	-3.269	4.581
Internet	3.362	2.802	-2.546	8.487
Mobile phone	4.513	0.532	2.239	5.175
GDP per capita	8.628	1.44	5.709	11.557
Natural resources rent	0.881	2.113	-7.932	4.079
Years of schooling	6.41	0.904	4	9
Trade openness	4.415	0.503	3.223	5.911

2020). Education, proxied with years of schooling, is expected to have a positive effect on democracy since education increases civic participation (Glaeser et al., 2007). GDP per capita (constant 2015 US\$) was used as a proxy for GDP per capita; trade openness is proxied with trade (% of GDP); internet penetration is proxied with secure Internet servers (per 1 million people); mobile phone penetration is represented with mobile cellular subscriptions (per 100 people); years of schooling represented with secondary education, duration (years) and natural resource rent is represented by total natural resources rents (% of GDP). Except for the years of schooling variable, the rest of the control variables were log-transformed before being used for the empirical estimation. All the control variables were retrieved from World Development Indicators.

- β_1 and β_k are the unknown parameters to be estimated and ε_i is the error term.

Table 1 provides descriptive statistics for all the variables used for the empirical analysis. As a cross-sectional study, all the variables considered belong to 2012.

The correlation between social media penetration and the democracy indices is presented in Fig. 1. Figure 1 shows a stronger positive correlation between social media penetration and democracy indices, indicating that increasing social media penetration increases all forms of democracy. While this bivariate correlation yields some insight into the relationship between social media penetration and democracy, we used econometric techniques to unravel the effect of social media on democracy, considering the effect of other variables.

3.2 Econometric Estimation Strategies

Similar to the study of Jha and Kodila-Tedika (2020), we estimated the baseline results using the ordinary least square (OLS) estimator. One of the weaknesses of OLS is its inability to handle endogeneity that might emerge from measurement error, reverse causality, or variable omission bias. Our model's first source of endogeneity is measurement error in social media penetration. Quintly, the organization responsible for Facebook user data, deployed an advertising tool that belongs to the Facebook corporation to obtain data on Facebook users across countries (Kodila-Tedika, 2021). Despite using advertising tools

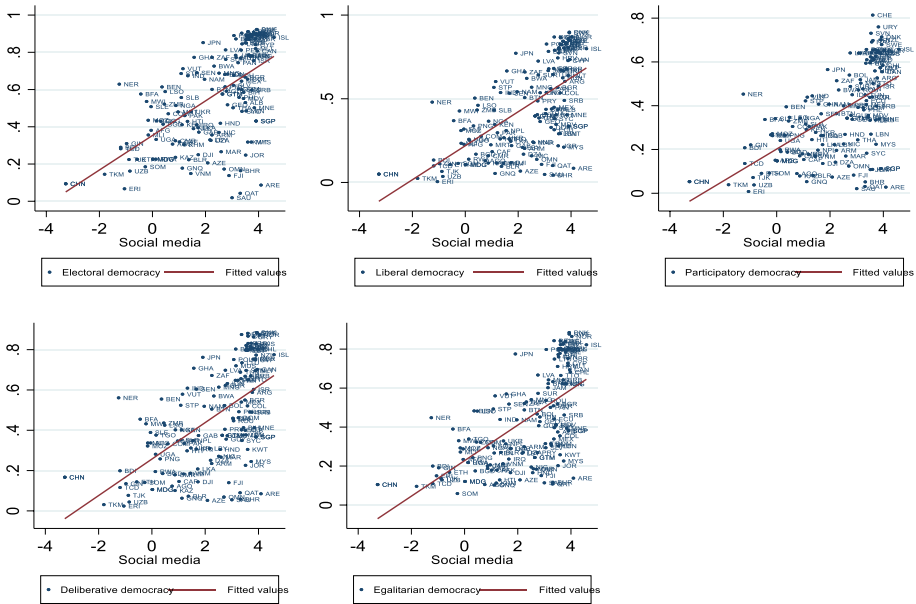


Fig. 1 Bivariate relationship between social media and democracy indices

belonging to Facebook, there seems to be an error regarding the data on the number of Facebook users across countries provided by Quintly. For instance, Kodila-Tedika (2021, p. 129) indicate that the data on Facebook users provided by Quintly should be interpreted with caution since Facebook claims that the data provided by Quintly is slightly different from the official number of Facebook users provided by Facebook. Despite the measurement error, the Quintly data on Facebook users have become the only available dataset that has been used in a number of studies, including Asongu et al. (2019), Jha and Kodila-Tedika (2020), Kodila-Tedika (2021) and Jha and Sarangi (2017). Another source of endogeneity is the reverse causality between democracy and social media penetration. While we have discussed the one-way effect of social media on democracy in the literature review section, democracy could also impact social media. At the core of democratic institutions is the freedom of expression. Social media is also a channel through which people can express their views on relevant national policy discourse. This indicates that democracy could increase social media penetration because of its fundamental principle of freedom of speech and expression. The failure to address these endogeneity sources could lead to a downward bias in the OLS estimates.

In relation to the above discussion, we adopted the instrumental variable regression technique to address endogeneity. Given that getting a reliable external instrument for identification was challenging, we specifically applied the Lewbel (2012) two-stage least squares technique to handle endogeneity issues as stated in Eqs. (2) and (3).

$$VDEM_i = \delta_o + \beta_1 \ln SM_i + \sum_{k=1}^N \beta_k X_i + \xi_1; \xi_i = \gamma_1 U + V_1 \tag{2}$$

$$\ln SM_i = \delta_1 + \sum_{k=1}^N \beta_k X_i + \xi_2; \xi_2 = \gamma_2 U + V_2 \quad (3)$$

where $VDEM_i$ denotes the democracy variables and $\ln SM_i$ represents social media penetration. U denotes unobserved characteristics that affect democracy and social media penetration. V_1 and V_2 are the idiosyncratic error terms. The Lewbel two-stage least squares technique involves taking vector Z of the observed exogenous covariates and applying $[Z - E(Z)]\xi_2$ as an instrument, provided that:

$$E(X\xi_1) = 0, E(X\xi_2), cov(Z, \xi_1, \xi_2) = 0 \quad (4)$$

There is heteroskedasticity in ξ_j . The vector Z may be a subset of X or equal to X . Given that ξ_2 is population parameter and it cannot be observed directly, we use the estimate of the sample parameter from the first stage equation (Eq. 3) and use the vector $[Z - E(Z)]\xi_2$ as the instrument. Generally, the Lewbel two-stage least square estimator is an external instrument-free estimator that constructs its internal heteroskedasticity-based instrument from the auxiliary equation residuals, which is then multiplied by each of the included exogenous variables in a mean-centred form (Lewbel, 2012). The Lewbel (2012) two-stage least square estimator yields efficient and consistent estimates robust to endogeneity and heteroskedasticity.

4 Results and Discussion

4.1 Baseline Results Estimated with OLS

The baseline results estimated using OLS are presented in Table 2. Table 2 depicts that irrespective of the specification, social media has an insignificant relationship with egalitarian democracy [Columns 9 and 10]. However, social media has a positive and statistically significant relationship to other forms of democracy, such as electoral, liberal, participatory and deliberative democracy, at a 1% or 5% significance level. Specifically, the estimated coefficient of the effect of social media on electoral democracy is 0.051 in Column 1 when we controlled for only internet and mobile phone penetrations and 0.045 in Column 2 when we further controlled for other control covariates such as GDP per capita, natural resources rent, years of schooling and trade openness. Consistently, the estimated effect of social media on liberal democracy is 0.036 in Column 3 and 0.032 in Column 4. Also, the estimated effect of social media on participatory democracy is 0.032 in Column 5 and 0.027 in Column 6. In Column 7, the estimated coefficient of the effect of social media on deliberative democracy is 0.034, and it is 0.031 in Column 8. These findings suggest that social media penetration significantly enhances democratic institutions. Social media improves democracy by promoting electoral competition, facilitating citizens' and organizations' participation in political process and public decision-making, promoting equality in rights and freedoms, and decentralization of political power (for instance, see Lorenz-Spreen et al., 2023; Mousavi & Gu, 2019; Schradie, 2012). These findings support Jha and Kodila-Tedika's (2020) empirical finding that social media has a significant positive relationship with Polity IV.

Many studies, including Campante et al. (2017) and Gavazza et al. (2018), have shown that internet penetration negatively affects electoral democracy. Others, such as Falck et al.

Table 2 social media and democracy [OLS estimates]

	Model 1 Electoral	Model 2	Model 3 Liberal	Model 4	Model 5 Participatory	Model 6	Model 7 Deliberative	Model 8	Model 9 Egalitarian	Model 10
Social media	0.051*** (0.014)	0.045*** (0.015)	0.036*** (0.013)	0.032** (0.015)	0.032*** (0.010)	0.027** (0.012)	0.034*** (0.012)	0.031** (0.013)	0.015 (0.012)	0.012 (0.014)
Internet	0.048*** (0.008)	0.072*** (0.019)	0.065*** (0.007)	0.086*** (0.018)	0.044*** (0.006)	0.065*** (0.015)	0.055*** (0.007)	0.069*** (0.018)	0.069*** (0.007)	0.079*** (0.017)
Mobile phone	-0.131*** (0.048)	-0.046 (0.054)	-0.128*** (0.043)	-0.049 (0.052)	-0.107*** (0.035)	-0.039 (0.042)	-0.1104** (0.044)	-0.032 (0.052)	-0.096*** (0.035)	-0.057 (0.045)
GDP per capita		-0.071** (0.035)		-0.055* (0.032)		-0.053** (0.027)		-0.046 (0.031)		-0.030 (0.029)
Natural resources rent		-0.026** (0.012)		-0.018 (0.012)		-0.017* (0.009)		-0.023** (0.011)		-0.018* (0.010)
Years of schooling		-0.002 (0.016)		-0.003 (0.016)		0.005 (0.014)		-0.009 (0.015)		0.016 (0.014)
Trade openness		-0.139*** (0.036)		-0.147*** (0.035)		-0.139*** (0.033)		-0.147*** (0.035)		-0.096*** (0.032)
Constant	0.885*** (0.201)	1.688*** (0.318)	0.734*** (0.177)	1.466*** (0.283)	0.633*** (0.145)	1.325*** (0.246)	0.678*** (0.180)	1.432*** (0.293)	0.605*** (0.143)	0.995*** (0.237)
Observations	141	128	141	128	141	128	141	128	141	128
R2	0.453	0.557	0.541	0.623	0.460	0.575	0.472	0.564	0.589	0.635

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(2014), have indicated that internet penetration plays no significant role in electoral democracy. However, our results affirm that internet penetration has a positive and statistically significant effect on the democracy indices. The estimated coefficients show that internet penetration increases electoral democracy by 0.048 to 0.072, liberal democracy by 0.065 to 0.086, participatory democracy by 0.044 to 0.065, deliberative democracy by 0.055 to 0.069 and egalitarian democracy by 0.069 to 0.079. Also, the results indicate that mobile phone penetration negatively affects democracy variables. However, the impact is statistically insignificant in models that account for GDP per capita, natural resources rent, years of schooling and trade openness, suggesting that these variables could mediate the effect of mobile penetration on democracy. In the baseline models, mobile phone penetration reduces electoral democracy by 0.131, liberal democracy by 0.128, participatory democracy by 0.107, deliberative democracy by 0.104 and egalitarian democracy by 0.096.

The results show that GDP per capita has a statistically significant negative relationship with electoral, liberal, and participatory democracy. The results imply that an increase in GDP per capita is associated with a 0.071 reduction in electoral democracy, 0.005 reduction in liberal democracy and 0.053 reduction in participatory democracy. The negative relationship between GDP and the democracy variables could arise from the role of high GDP per capita in social inequality. Rising social and income inequalities due to GDP per capita could increase social tensions and political instability, consequently destabilizing democratic institutions. This result differs from Barro (1999) and Heo and Tan (2001), who found a positive relationship between GDP per capita and democracy. Contrarily, GDP per capita has a statistically insignificant relationship with deliberative and egalitarian democracy. These results indicate that the impact of GDP per capita on democracy depends on how democracy is conceptualized and measured. Previous studies, including Csordás and Ludwig (2011) and Jha and Kodila-Tedika (2020), documented that GDP per capita does not explain democracy.

Consistent with the political “resources curse theory” and the findings of Barro (1999) and Sarah M Brooks and Kurtz (2022), our finding confirms that natural resources rent has a statistically significant negative relationship with electoral, participatory, deliberative, and egalitarian democracy. The results imply that natural resources rent is associated with a 0.026 reduction in electoral democracy, 0.017 reduction in participatory democracy, 0.023 reduction in deliberative democracy and 0.018 reduction in egalitarian democracy. However, natural resources have an insignificant effect on liberal democracy. Consistent with Li and Reuveny’s (2003) findings, the results in Table 2 highlight that trade openness has a statistically significant negative relationship with electoral, liberal, participatory, deliberative, and egalitarian democracy. The results imply that trade openness is associated with a 0.139 reduction in electoral democracy, 0.147 reduction in liberal democracy, 0.139 reduction in participatory democracy, 0.147 reduction in deliberative democracy and 0.096 reduction in egalitarian democracy. Also, similar to the findings of Jha and Kodila-Tedika (2020), the estimates indicate that years of schooling have a statistically insignificant effect on the democracy variables, indicating that schooling is not a key determinant of democracy.

4.2 Endogeneity-Corrected Results

The section reports the endogeneity-corrected results from the Lewbel 2SLS estimator. The Lewbel 2SLS results are presented in Table 3. Table 3 shows that across all the specifications, social media has a positive and statistically significant effect on the democracy

Table 3 social media and democracy [Lewbel 2SLS]

	Model 1 Electoral	Model 2	Model 3 Liberal	Model 4	Model 5 Participatory	Model 6 Deliberative	Model 7 Deliberative	Model 8	Model 9 Egalitarian	Model 10
Social media	0.075*** (0.019)	0.090*** (0.017)	0.061*** (0.017)	0.072*** (0.016)	0.047*** (0.014)	0.061*** (0.015)	0.062*** (0.020)	0.069*** (0.019)	0.034** (0.015)	0.049*** (0.015)
Internet	0.039*** (0.009)	0.049*** (0.020)	0.056*** (0.009)	0.066*** (0.019)	0.039*** (0.007)	0.048*** (0.017)	0.044*** (0.009)	0.050*** (0.019)	0.062*** (0.008)	0.060*** (0.018)
Mobile phone	-0.154*** (0.053)	-0.110*** (0.055)	-0.152*** (0.046)	-0.107*** (0.052)	-0.121*** (0.038)	-0.089*** (0.044)	-0.131*** (0.048)	-0.087 (0.054)	-0.115*** (0.037)	-0.110*** (0.045)
GDP per capita		-0.056 (0.035)		-0.042 (0.032)		-0.042 (0.027)		-0.033 (0.032)		-0.017 (0.029)
Natural resources rent		-0.025** (0.013)		-0.018 (0.012)		-0.017* (0.010)		-0.023* (0.012)		-0.017 (0.011)
Years of schooling		0.002 (0.015)		0.001 (0.016)		0.008 (0.014)		-0.006 (0.015)		0.019 (0.014)
Trade openness		-0.132*** (0.034)		-0.140*** (0.034)		-0.133*** (0.032)		-0.140*** (0.034)		-0.090*** (0.030)
Constant	0.966*** (0.218)	1.772*** (0.322)	0.816*** (0.190)	1.542*** (0.285)	0.684*** (0.157)	1.389*** (0.246)	0.773*** (0.198)	1.503*** (0.288)	0.670*** (0.153)	1.064*** (0.238)
Observations	141	128	141	128	141	128	141	128	141	128
R2	0.446	0.532	0.534	0.605	0.456	0.553	0.461	0.546	0.583	0.618

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

indices at a 1% level. The Lewbel 2SLS coefficients are relatively higher than the OLS estimates. For instance, The Lewbel 2SLS estimates suggest that social media increases electoral democracy by 0.075 in Column 1 and 0.090 in Column 2. Also, social media increases liberal democracy by 0.061 in Column 3 and 0.072 in Column 4. At the same time, social media increases participatory democracy by 0.047 in Column 5 and 0.061 in Column 6. In Column 7, the estimated coefficient of the effect of social media on deliberative democracy is 0.062, and it is 0.069 in Column 8. Finally, social media penetration increases egalitarian democracy by 0.034 in Column 9 and 0.049 in Column 10. These results consistently suggest that social media penetration improves democratization even after accounting for endogeneity.

Both the OLS and the Lewbel 2SLS results support the notion that social media penetration is key for enhancing democracy. However, the OLS and the Lewbel 2SLS estimates (coefficients) on the social media variables are relatively small compared to what is established in a closely related study. For instance, Jha and Kodila-Tedika (2020), in their study, established from OLS that estimates (coefficients) of the effect of social media (Facebook penetration) on Polity IV range between 0.412 to 0.650 and from two-stages least square (instrumenting internet penetration), the estimated coefficients on the effect of social media on Polity IV ranges between 0.437 to 0.821. The size of these estimated coefficients from Jha and Kodila-Tedika's (2020) study is larger than that of the estimated coefficients established in this study. This analysis proves that even if social media statistically improves the different forms of democracy considered in this study, the effect (size of the coefficients) is relatively small.

The relationship between the control variables and democracy based on the Lewbel 2SLS technique is not qualitatively different from the OLS results. For instance, the Lewbel 2SLS consistently shows that internet penetration has a positive and statistically significant effect on the democracy indices at a 1% level. Also, mobile phone penetration consistently has negative and statistically significant effects on the democracy variables across all specifications. Further, natural resources and trade openness have a statistically significant negative impact on the democracy indices. The Lewbel 2SLS estimates indicate that both GDP per capita and years of schooling have a statistically insignificant effect on the democracy variables.

4.3 Does the Effect of Social Media on Democracy Differ Across Income Groups?

As presented in Appendix Figure 5, the democracy indices differ among countries at different stages of economic development. Generally, Appendix Figure 5 shows that democracy is higher in high-income, upper-middle-income, lower-middle-income, and, lastly, low-income countries. In this section, we examine whether social media penetration's impact on democracy differs across countries at different stages of economic development. We estimated the income group models using the Lewbel IV-2SLS estimator, and the results are presented in Fig. 2.⁴ Figure 2 shows the effect of social media on the democracy variables across countries at different stages of economic development while accounting for GDP

⁴ We presented the coefficients for social media using graphs in order to conserve space and provide a pictorial presentation of the income groups. However, the extensive tables containing the estimates for the social media variable and the control variables on the democracy variables across the income group would be made available upon request.

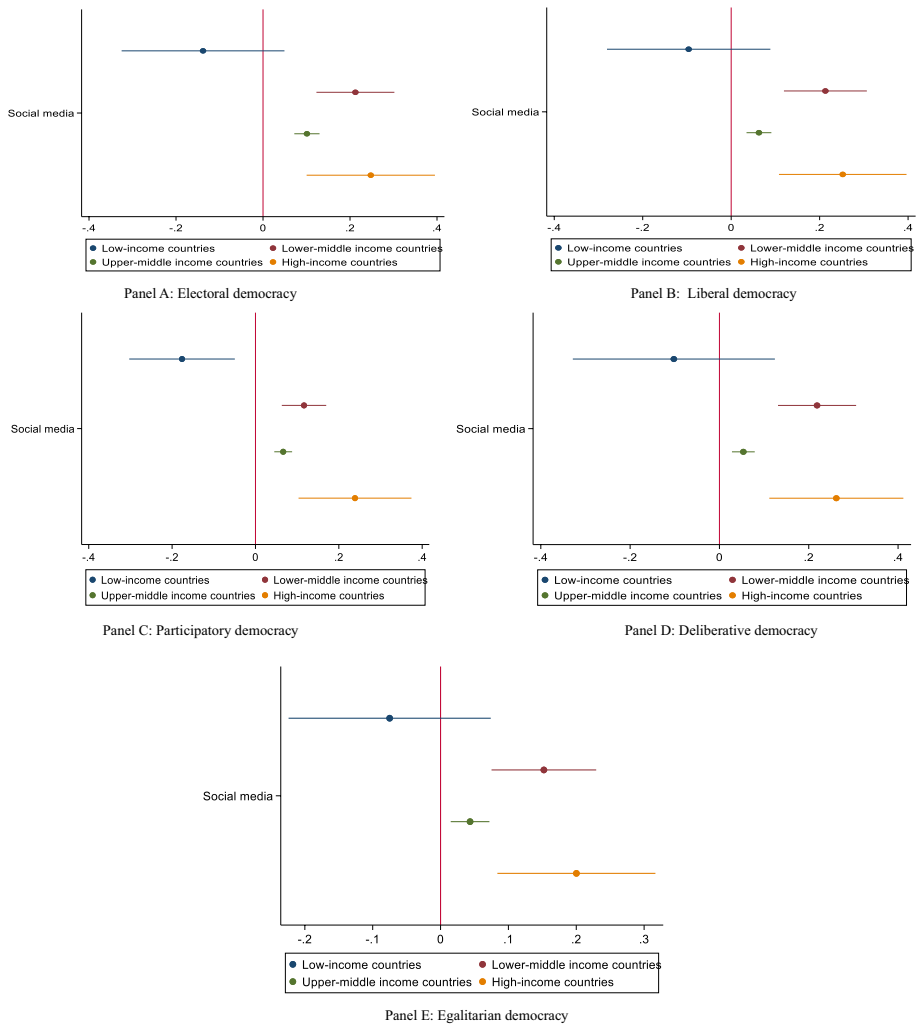


Fig. 2 Lewbel IV-2SLS regression coefficients of the effect of social media on democracy variables (Lewbel IV-2SLS estimates and 90% confidence interval) across income groups. All regression models include control variables (GDP per capita, trade openness, natural resources rent, internet penetration, years of schooling, and mobile phone penetration)

per capita, trade openness, natural resources rent, internet penetration, years of schooling, and mobile phone penetration.

Figure 2 Panel A suggests that social media has a positive and statistically significant effect on electoral democracy in lower-middle, upper-middle and high-income economies, while it has an insignificant negative effect on electoral democracy in low-income economies. Social media increases electoral democracy by 0.212 in lower-middle income countries, 0.101 in upper-middle income countries and 0.248 in high-income economies. Figure 1 Panel B suggests that social media has a positive and statistically significant effect on liberal democracy in lower-middle, upper-middle and high-income economies, while it has

an insignificant negative effect on electoral democracy in low-income economies. Social media increases liberal democracy by 0.213 in lower-middle income countries, 0.063 in upper-middle income countries and 0.252 in high-income economies

Figure 2 Panel C suggests that social media has a positive and statistically significant effect on participatory democracy in lower-middle, upper-middle and high-income economies. Social media increases participatory democracy by 0.117 in lower-middle income countries, 0.067 in upper-middle income countries and 0.239 in high-income economies. At the same time, social media has a statistically significant negative effect on participatory democracy in low-income economies, with an estimated coefficient of 0.239. Figure 2 Panel D suggests that social media has a positive and statistically significant effect on deliberative democracy in lower-middle, upper-middle, and high-income economies, while it has an insignificant negative effect on deliberative democracy in low-income economies. Social media increases deliberative democracy by 0.219 in lower-middle income countries, 0.054 in upper-middle income countries and 0.262 in high-income economies. Finally, Fig. 2 Panel E suggests that social media has a positive and statistically significant effect on egalitarian democracy in lower-middle, upper-middle and high-income economies, while it has an insignificant negative effect on egalitarian democracy in low-income economies. Social media increases electoral democracy by 0.152 in lower-middle income countries, 0.044 in upper-middle income countries and 0.200 in high-income countries

Generally, the evidence suggests that social media penetration enhances democracy in high-income economies, followed by lower-middle and upper-middle income economies. However, in low-income economies, social media penetration has a negative effect on democracy indices. The role of social media in limiting democratization in low-income countries could be attributed to the lower penetration of social media. However, in high-income, upper-middle-income, and lower-middle-income countries, higher social media penetration contributes significantly to democracy. As depicted in Appendix Figure 6, social media penetration is lowest in low-income countries, while social media penetration is higher in high-income countries, followed by upper-middle-income countries and lower-middle income countries. The results of this income group analysis contradict Jha and Kodila-Tedika's (2020) finding that social media penetration increases democracy in low-income countries.

4.4 Does the Effect of Social Media on Democracy Differ Across Regions?

We further extend the analysis to examine the impact of social media penetration on democracy across regions. Appendix Figures 7 and 8 highlight that democracy and social media penetration are not homogenous across geographical regions. We estimated the regional results using the Lewbel IV-2SLS estimator, and the results are presented in Fig. 3.⁵ Figure 3 provides a pictorial presentation of the effect of social media on the democracy variables across different regional groups while accounting for GDP per capita, trade openness, natural resources rent, internet penetration, years of schooling, and mobile phone penetration. We estimated one model by restricting the sample to only South Asia and Sub-Saharan Africa countries since countries in these regions, on average, have relatively the lowest

⁵ We presented the coefficients for social media using graphs in order to conserve space and provide a pictorial presentation of the regional groups. However, the extensive tables containing the estimates for the social media variable and the control variables on the democracy variables across the regions would be made available upon request.

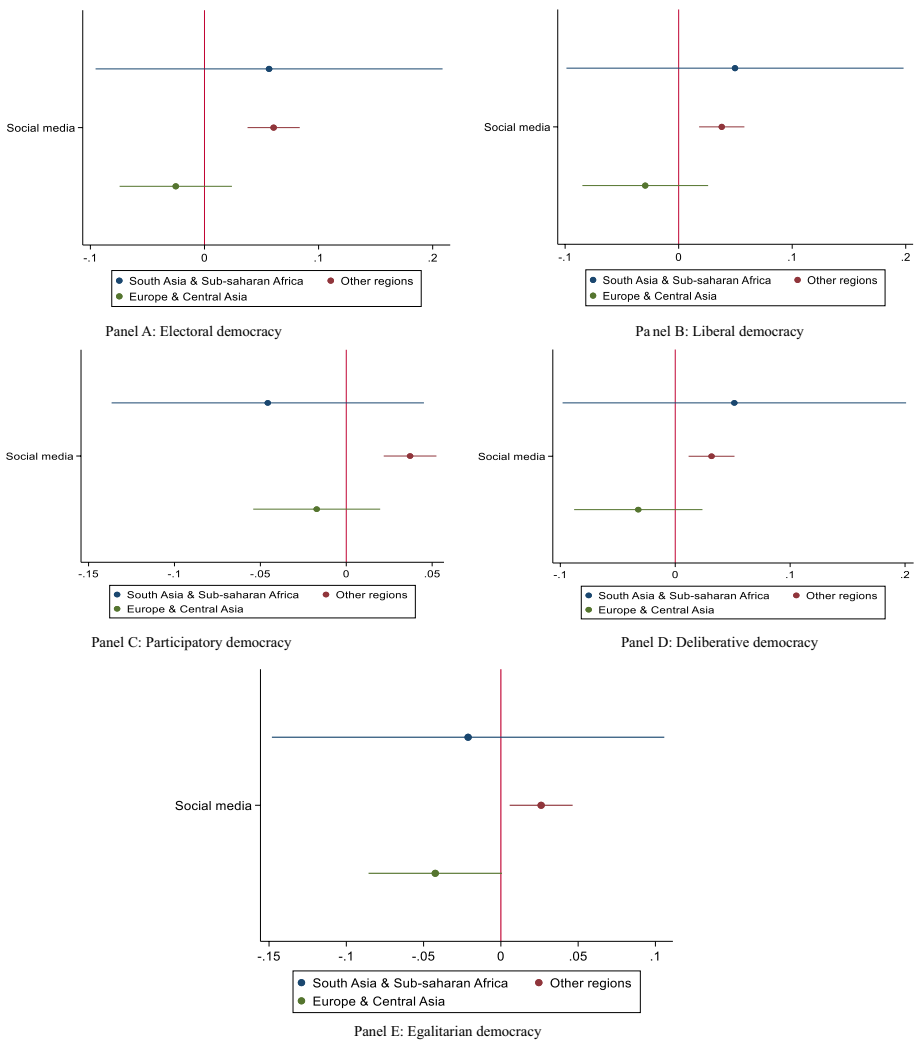


Fig. 3 Lewbel IV-2SLS regression coefficients of the effect of social media on democracy variables (Lewbel IV-2SLS estimates and 90% confidence interval) across geographical regions. All regression models include control variables (GDP per capita, trade openness, natural resources rent, internet penetration, years of schooling, and mobile phone penetration)

social medial penetration (see Appendix Figure 8). We also estimated another model by restricting the sample to only Europe and Central Asia countries because, on average, countries in these regions have relatively higher social media penetration (see Appendix Figure 8). Finally, we estimated another model by restricting the sample to other regions, including East Asia & Pacific, America (which involves Canada and Latin America & Caribbean countries) and the MENA countries.

Figure 3 Panel A suggests that social media positively affects electoral democracy in South Asia, Sub-Saharan Africa, and other regions; however, the impact is statistically significant in other regions with an estimated effect of 0.061. In Europe and Central Asia,

social media has an insignificant negative effect on electoral democracy. Figure 3 Panel B suggests that social media positively affects liberal democracy in South Asia, Sub-Saharan Africa, and other regions; however, the impact is statistically significant in other regions with an estimated effect of 0.038. In Europe and Central Asia, social media has an insignificant negative effect on liberal democracy. Figure 3 Panel C suggests that social media positively affects participatory democracy in South Asia, Sub-Saharan Africa, and other regions; however, the impact is statistically significant in other regions with an estimated effect of 0.037. In Europe and Central Asia, social media has an insignificant negative effect on participatory democracy. Figure 3 Panel D suggests that social media positively affects deliberative democracy in South Asia, Sub-Saharan Africa, and other regions; however, the impact is statistically significant in other regions with an estimated effect of 0.032. In Europe and Central Asia, social media has an insignificant negative effect on deliberative democracy. Figure 3 Panel E suggests that social media positively affects egalitarian democracy in South Asia, Sub-Saharan Africa, and other regions; however, the impact is statistically significant in other regions with an estimated effect of 0.026. In Europe and Central Asia, social media has an insignificant negative effect on egalitarian democracy.

In summary, the regional analysis implies that social media is not a significant determinant of democracy in sub-Saharan Africa, South Africa, Europe, and Central Asia countries. However, the findings highlighted that East Asia & Pacific, America and the MENA countries have benefited politically from social media penetration. In other words, social media penetration has enhanced electoral, egalitarian, participatory, liberal, and deliberative democracies in countries in East Asia & Pacific, America and the MENA regions.

4.5 Does the Effect of Social Media on Democracy Depend on Internet Penetration?

We argue that social media is a complementary good, indicating that the ability of social media to function effectively depends on other goods, such as internet access. One cannot effectively log on to Facebook without the internet. Therefore, we hypothesize that social media's impact on democracy depends on internet penetration. Table 4 shows the interactive effect of social media and internet penetration on democracy. In Table 4, the unconditional effect shows that social media has an insignificant effect on electoral, liberal, participatory, deliberative, and egalitarian democracies. At the same time, internet penetration has a statistically significant positive effect on electoral, liberal, participatory, deliberative, and egalitarian democracies. We evaluated the marginal effect of social media penetration on the democracy variables conditioned at different levels of internet penetration using Eq. (5):

$$\frac{\partial VDEM}{\partial \ln SM} = \beta_1 + \delta_1 \times \text{Internet penetration} \quad (5)$$

where β_1 represents social media coefficients and δ_1 is the coefficient of the interaction term [social media \times internet penetration]. We evaluated the marginal effect of social media at the minimum (-2.546), mean (3.362) and maximum (8.487) values of internet penetration.

The marginal effect of social media penetration suggests that, at higher values of internet penetration, social media has a positive and statistically significant effect on electoral, liberal, participatory, deliberative, and egalitarian democracies. For instance, the marginal effects indicate that at the minimum value of internet penetration, social media has a negative effect on electoral, liberal, participatory, deliberative, and egalitarian democracies; however, the impact is only significant in the egalitarian democracy

Table 4 Interaction effect of social media and internet penetration on democracy

	Model 1	Model 2	Model 3	Model 4	Model 5
	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Social media	0.027 (0.017)	0.013 (0.016)	0.011 (0.013)	0.013 (0.015)	-0.009 (0.015)
Internet	0.044** (0.022)	0.058*** (0.020)	0.041** (0.016)	0.042** (0.020)	0.047*** (0.017)
Social media × Internet	0.012** (0.005)	0.012** (0.005)	0.010*** (0.004)	0.012** (0.005)	0.014*** (0.004)
Mobile phone	0.029 (0.064)	0.030 (0.060)	0.026 (0.046)	0.042 (0.059)	0.030 (0.051)
GDP per capita	-0.097*** (0.036)	-0.083** (0.033)	-0.077*** (0.028)	-0.073** (0.034)	-0.061** (0.030)
Natural resources rent	-0.024** (0.012)	-0.017 (0.011)	-0.016* (0.009)	-0.022* (0.011)	-0.016 (0.010)
Years of schooling	-0.008 (0.016)	-0.008 (0.017)	-0.000 (0.015)	-0.015 (0.016)	0.009 (0.015)
Trade openness	-0.154*** (0.037)	-0.162*** (0.036)	-0.152*** (0.033)	-0.162*** (0.036)	-0.113*** (0.032)
Constant	1.677*** (0.314)	1.454*** (0.280)	1.315*** (0.244)	1.420*** (0.292)	0.982*** (0.237)
Observations	128	128	128	128	128
R2	0.573	0.639	0.594	0.581	0.659
<i>Marginal effect of social media on democracy at different values of internet penetration</i>					
<i>Minimum</i>	-0.003 (0.027)	-0.019 (0.026)	-0.016 (0.020)	-0.018 (0.025)	-0.043** (0.022)
<i>Mean</i>	0.067*** (0.016)	0.055*** (0.015)	0.046*** (0.012)	0.052*** (0.014)	0.037*** (0.014)
<i>Maximum</i>	0.128*** (0.037)	0.119*** (0.035)	0.100*** (0.027)	0.113*** (0.035)	0.108*** (0.029)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

model. However, at the mean and maximum values of internet penetration, social media has a positive and statistically significant effect on electoral, liberal, participatory, deliberative, and egalitarian democracies. The estimated effect suggests that at the mean value of internet penetration, social media increases electoral democracy by 0.067, liberal democracy by 0.055, participatory democracy by 0.046, deliberative democracy by 0.052, and egalitarian democracy by 0.037. Also, at the maximum value of internet penetration, social media increases electoral democracy by 0.128, liberal democracy by 0.119, participatory democracy by 0.100, deliberative democracy by 0.113, and egalitarian democracy by 0.108. These conditional effect results affirm that for social media (Facebook) to enhance democracy, there should be higher internet penetration. Therefore, in countries with poor internet access, social media would not enhance democracy and vice versa.

Table 5 Effect of social media on the distribution of democracy [MMQR estimates]

	Location	Scale	Model 1 0.1	Model 2 0.5	Model 3 0.9
<i>Panel A: Electoral democracy</i>					
Social media	0.045** (0.018)	0.010 (0.012)	0.029 (0.034)	0.047*** (0.017)	0.059*** (0.017)
Internet	0.072*** (0.022)	-0.025* (0.014)	0.114*** (0.040)	0.067*** (0.021)	0.035* (0.020)
Mobile phone	-0.046 (0.067)	-0.016 (0.043)	-0.018 (0.123)	-0.049 (0.063)	-0.070 (0.063)
GDP per capita	-0.071* (0.038)	0.029 (0.025)	-0.119* (0.071)	-0.065* (0.036)	-0.028 (0.036)
Natural resources rent	-0.026*** (0.010)	0.004 (0.006)	-0.033* (0.018)	-0.025*** (0.009)	-0.019** (0.009)
Years of schooling	-0.002 (0.019)	-0.001 (0.012)	0.000 (0.035)	-0.002 (0.018)	-0.004 (0.018)
Trade openness	-0.139*** (0.040)	0.072*** (0.026)	-0.262*** (0.075)	-0.126*** (0.039)	-0.033 (0.038)
Constant	1.688*** (0.361)	-0.283 (0.236)	2.169*** (0.668)	1.635*** (0.343)	1.273*** (0.339)
Observations			128	128	128
<i>Panel B: Liberal democracy</i>					
Social media	0.032** (0.016)	0.008 (0.008)	0.020 (0.021)	0.032** (0.016)	0.044** (0.020)
Internet	0.086*** (0.019)	-0.022** (0.010)	0.119*** (0.025)	0.086*** (0.019)	0.052** (0.023)
Mobile phone	-0.049 (0.057)	-0.002 (0.030)	-0.046 (0.074)	-0.049 (0.057)	-0.053 (0.070)
GDP per capita	-0.055* (0.033)	0.023 (0.017)	-0.089** (0.043)	-0.055* (0.033)	-0.020 (0.040)
Natural resources rent	-0.018** (0.009)	-0.000 (0.005)	-0.018 (0.012)	-0.018** (0.009)	-0.019* (0.011)
Years of schooling	-0.003 (0.017)	-0.006 (0.009)	0.006 (0.022)	-0.003 (0.017)	-0.011 (0.021)
Trade openness	-0.147*** (0.036)	0.064*** (0.019)	-0.241*** (0.048)	-0.146*** (0.037)	-0.049 (0.044)
Constant	1.466*** (0.305)	-0.240 (0.160)	1.819*** (0.401)	1.464*** (0.308)	1.102*** (0.374)
Observations			128	128	128
<i>Panel C: Participatory democracy</i>					
Social media	0.027* (0.015)	0.004 (0.008)	0.020 (0.021)	0.027* (0.015)	0.033* (0.017)
Internet	0.065*** (0.017)	-0.024** (0.009)	0.102*** (0.025)	0.066*** (0.017)	0.029 (0.020)
Mobile phone	-0.039 (0.049)	-0.030 (0.028)	0.007 (0.072)	-0.038 (0.050)	-0.085 (0.058)

Table 5 (continued)

	Location	Scale	Model 1 0.1	Model 2 0.5	Model 3 0.9
GDP per capita	-0.053* (0.030)	0.042*** (0.016)	-0.119*** (0.044)	-0.055* (0.031)	0.011 (0.035)
Natural resources rent	-0.017* (0.009)	-0.002 (0.005)	-0.013 (0.013)	-0.017* (0.009)	-0.021** (0.010)
Years of schooling	0.005 (0.015)	-0.006 (0.008)	0.014 (0.022)	0.005 (0.015)	-0.004 (0.018)
Trade openness	-0.139*** (0.034)	0.062*** (0.019)	-0.234*** (0.050)	-0.141*** (0.035)	-0.045 (0.039)
Constant	1.325*** (0.274)	-0.277* (0.152)	1.750*** (0.399)	1.336*** (0.279)	0.906*** (0.320)
Observations			128	128	128
<i>Panel D: Deliberative democracy</i>					
Social media	0.031** (0.016)	0.014* (0.008)	0.008 (0.021)	0.031* (0.016)	0.051*** (0.019)
Internet	0.069*** (0.019)	-0.026*** (0.010)	0.112*** (0.026)	0.069*** (0.020)	0.030 (0.023)
Mobile phone	-0.032 (0.056)	-0.001 (0.028)	-0.031 (0.076)	-0.032 (0.056)	-0.034 (0.067)
GDP per capita	-0.046 (0.033)	0.028* (0.017)	-0.092** (0.045)	-0.046 (0.034)	-0.004 (0.040)
Natural resources rent	-0.023** (0.009)	0.002 (0.005)	-0.026** (0.012)	-0.023** (0.009)	-0.020* (0.011)
Years of schooling	-0.009 (0.017)	0.008 (0.008)	-0.023 (0.022)	-0.009 (0.017)	0.004 (0.020)
Trade openness	-0.147*** (0.034)	0.053*** (0.017)	-0.232*** (0.046)	-0.146*** (0.035)	-0.067* (0.041)
Constant	1.432*** (0.309)	-0.330** (0.157)	1.964*** (0.416)	1.430*** (0.315)	0.940** (0.367)
Observations			128	128	128
<i>Panel E: Egalitarian democracy</i>					
Social media	0.012 (0.014)	0.016** (0.007)	-0.011 (0.016)	0.010 (0.014)	0.037** (0.019)
Internet	0.079*** (0.017)	-0.031*** (0.009)	0.124*** (0.020)	0.083*** (0.018)	0.029 (0.023)
Mobile phone	-0.057 (0.048)	0.003 (0.024)	-0.061 (0.055)	-0.057 (0.048)	-0.052 (0.065)
GDP per capita	-0.030 (0.030)	0.034** (0.015)	-0.080** (0.034)	-0.034 (0.030)	0.024 (0.040)
Natural resources rent	-0.018** (0.008)	-0.001 (0.004)	-0.016* (0.009)	-0.017** (0.008)	-0.020* (0.011)
Years of schooling	0.016 (0.015)	-0.010 (0.007)	0.030* (0.017)	0.017 (0.015)	0.000 (0.020)
Trade openness	-0.096***	0.043***	-0.160***	-0.102***	-0.028

Table 5 (continued)

	Location	Scale	Model 1 0.1	Model 2 0.5	Model 3 0.9
	(0.031)	(0.016)	(0.036)	(0.032)	(0.042)
Constant	0.995*** (0.273)	-0.243* (0.136)	1.350*** (0.312)	1.030*** (0.275)	0.615* (0.368)
Observations			128	128	128

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.6 Accounting for the Distribution of Democracy Variables

Appendix Figure 9 shows that the democracy variables are not normally distributed. We further conducted a robustness check by examining the effect of social media on the democracy variable by considering the distributional properties of the democracy variables. We adopted Machado and Silva's (2019) method of moment quantile regression (MMQR), which accounts for distributional heterogeneity and fixed effects, to estimate the effect of social media on the distribution of democracy variables. Table 5 presents the MMQR results. Table 5 shows that social media has a statistically insignificant effect on the lower quantile (0.1 quantile) of electoral democracy; however, social media has a positive and statistically significant effect on the mean and higher quantile (0.5 and 0.9 quantile) of electoral democracy. Similarly, social media has an insignificant effect on the lower quantile (0.1 quantile) of liberal democracy; however, social media has a positive and statistically significant effect on liberal democracy at the higher quantile (0.5 and 0.9 quantile). Social media has a neutral impact on participatory democracy at the lower quantile (0.1 quantile); however, social media has a positive and statistically significant effect on participatory democracy at the higher quantile (0.5 and 0.9 quantile). Social media also has an insignificant effect on deliberative democracy at the lower quantile (0.1 quantile); however, social media has a positive and statistically significant effect on deliberative democracy at the higher quantile (0.5 and 0.9 quantile). Finally, social media penetration only has a statistically significant positive effect on egalitarian democracy at the higher quantiles but insignificant on egalitarian democracy at the 0.1 and 0.5 quantiles. These findings generally support that social media improves democracy.

4.7 Testing for the Model's Robustness and Influence

In this section, we test for the model uncertainty and the robustness of the results to our model specifications. We, therefore, follow Young and Holsteen's (2017) analytical approach to evaluate the model uncertainty and the robustness of the effect of social media on the democracy variables. The details of the model uncertainty and the robustness statistics are presented in Appendix Tables 7, 8, 9, 10 and 11. As presented in Appendix Tables 7, 8, 9, 10 and 11, 64 unique combinations of the control variables exist. The modelling distribution displayed by Panel A–E of Fig. 4 is the estimated coefficients of social media stored during the estimation of these 64 ($2^6 = 64$) unique models. As displayed in Fig. 1, the estimated coefficients on the effect of social media penetration on electoral, liberal, participatory, egalitarian, and deliberative democracy

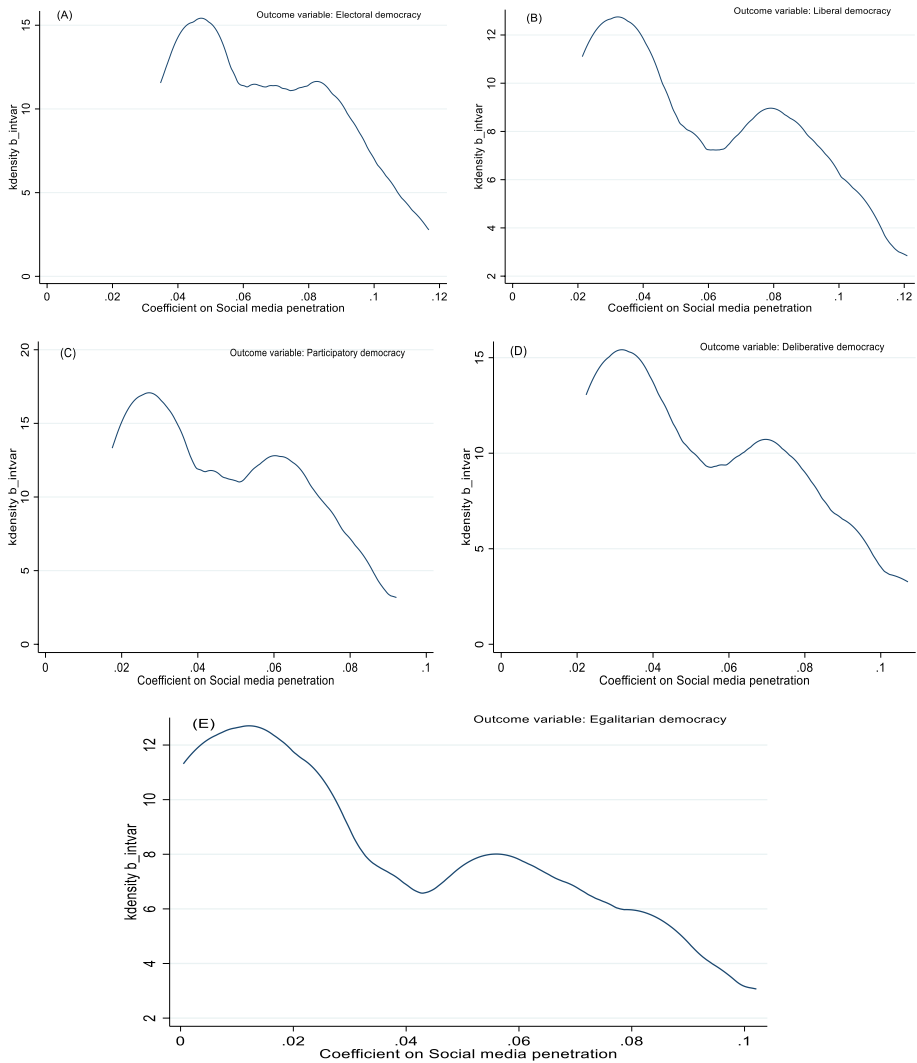


Fig. 4 Modeling distribution of the effect of social media penetration on the democracy variables

are positive and significant in every combination of the control variables. In Appendix Table 7, the robustness ratio is 2.3901, indicating that social media has a stronger robust effect on electoral democracy, which agrees with the 100% sign and significant rate. Also, robustness ratios of 1.7258 (see Appendix Table 8), 1.8520 (see Appendix Table 9) and 1.7493 (see Appendix Table 10) suggest that social media penetration has a strong robust effect on liberal, participatory, and deliberative democracy, which agrees with their respective sign and significant rate. On the other hand, the robustness ratio of 1.0771 in Appendix Table 11 suggests that social media has a weaker robust effect on egalitarian democracy, which agrees with the 50% sign and significant rate. In summary, social media penetration has a robust positive effect on electoral, liberal,

participatory, egalitarian, and deliberative democracy, indicating that social media penetration is important for improvement in democratic institutions across the globe.

In Appendix Table 7, the model influence statistics indicates that all things being equal, controlling for internet penetration, natural resources rent and GDP per capita reduce the effect of social media penetration on electoral democracy by 0.0418 (63.7%), 0.0096 (14.6%), and 0.0076 (11.6%) respectively. Contrarily, mobile phones, trade openness and years of school increase the effect of social media penetration on electoral democracy by 0.0151 (22.9%), 0.0017 (2.5%) and 0.0002 (0.3%), respectively. Also, in Appendix Table 8, controlling for the effect of internet penetration, GDP per capita, and natural resources reduce the effect of social media penetration on liberal democracy by 0.0555 (95%), 0.0147 (25.2%) and 0.0094 (16.2%) respectively while mobile phone, trade openness and years of schooling increase the effect of social media penetration by 0.0133 (22.8%), 0.0016 (2.7%) and 0.0002 (0.3%).

As presented in Appendix Table 9, controlling for internet penetration, GDP per capita and natural resources rent reduce the effect of social media penetration on participatory democracy by 0.0393 (85.9%), 0.0087 (19.1%), and 0.0076 (16.6%), respectively. Mobile phones, trade openness, and years of school increase the effect of social media penetration by 0.0122 (26.8%), 0.0016 (3.6%), and 0.0006 (1.4%), respectively. In Appendix Table 10, internet penetration, GDP per capita, natural resources rent, and years of schooling reduce the effect of social media penetration on deliberative democracy by 0.0454 (85.3%), 0.0119 (22.3%), 0.0092 (16.6%) and 0.0002 (0.4%) respectively while mobile phone and trade openness increase the effect of social media penetration by 0.0113 (21.1%), and 0.0016(3.1%). Finally, in Appendix Table 11, internet penetration, GDP per capita and natural resources rent reduce the effect of social media penetration on egalitarian democracy by 0.0571 (152.0%), 0.0177 (47.2%), and 0.0094 (25%) respectively while mobile phone, trade openness and years of school increase the effect of social media penetration by 0.0109 (29.1%), 0.0013 (3.3%) and 0.0008(2.2%) respectively.

5 Conclusion and Policy Implications

The contribution of social media to democratic institutions is still contentious in the political science literature. While some scholars argue theoretically that social media is useful for enhancing democracy, others claim that social media hinders democratic institutions. In view of this theoretical inconsistency, we contribute to the literature by providing empirical evidence on whether social media enhances democracy using cross-sectional data from 145 countries. We used Facebook penetration as a proxy for social media. As a novelty and contribution to the literature, we captured democracy using varieties of high-level and multidimensional democracy indices, such as egalitarian, participatory, liberal, electoral, and deliberative democracies. In this study, we applied the Lewbel two-stage least square estimator to address endogeneity and further deployed the method of moment quantile regression to test the robustness of the results. After applying the Lewbel two-stage least square estimator to address endogeneity, the key findings that emerged from this study are summarized as follows:

First, the findings showed that social media penetration significantly improves varieties of high-level democracy indices such as egalitarian, participatory, liberal, electoral, and deliberative democracies. Second, the findings highlighted that the impact of social media penetration on democracy differs across countries at different stages of economic development. For instance, in low-income economies, social media penetration has a negative effect on egalitarian, participatory, liberal, electoral, and deliberative democracies. On the other

hand, social media penetration significantly improves egalitarian, participatory, liberal, electoral, and deliberative democracies in lower-middle, upper-middle, and high-income economies. Third, the findings revealed that social media significantly improves all the forms of democracy when we restrict the study sample to only East Asia & Pacific, America and the MENA region. On the other hand, social media penetration insignificantly affects all forms of democracy if the study sample is restricted to South Asia, sub-Saharan Africa, Europe, and Central Asia only. Fourth, the moderation and marginal effect analysis revealed that internet penetration conditions the effect of social media penetration, indicating that at the mean and maximum values of internet penetration, the positive effect of social media on the democracy variables increases. In contrast, at the minimum value of internet penetration, social media reduces democracy. Finally, in evaluating the model uncertainty and the robustness of the effect of social media, the findings showed that social media penetration has a robust positive effect on electoral, liberal, participatory, egalitarian, and deliberative democracy.

The policy implications of these findings are discussed as follows. The findings suggest that countries could leverage social media to enhance their democratic institutions. In this regard, policies that facilitate easy penetration and usage of social media enhance democracy. The findings also highlighted that the impact of social media on democracy also depends on internet penetration and that when internet penetration is low, social media reduces democracy; however, at higher internet penetration, social media could substantially improve democratic institutions. This finding highlights that policy measures that would increase internet usage while minimizing the cost of internet usage would benefit democracy. While global internet access has improved globally; however, most internet users stay offline. As highlighted in the Global Connectivity 2022 report, one in three people who could go online choose not to stay offline because of the higher cost of internet usage, inability to use the internet, lack of awareness and lack of access to connectivity devices. Making internet costs affordable to scale up internet subscription and usage requires policy measures that subsidize internet service providers' activities and reduce tariffs on importing internet infrastructures. In addition, policy measures that enhance digital literacy and ensure sustainable energy supply to power internet infrastructures could facilitate internet penetration and usage. Improving internet usage also requires policies that could make the telecommunication sector more competitive since competition in the telecommunication sector could enable internet providers to provide different internet subscription plans at a more affordable cost and meet the needs of different internet consumers.

Despite the uniqueness and contribution of this paper to the discussion of the political implications of social media penetration, our findings should be interpreted with some caveats. Our study is limited by only focusing on the contribution of Facebook penetration on different forms of democratic institutions across the globe. However, other social media platforms, such as Twitter, WhatsApp, Tiktok, Twitch, Mastodon, Clubhouse, and others, could equally influence democracy across the globe. The political implications of these other social media platforms are not considered in this study because of the difficulty in accessing official data on the number of people who use these social media platforms. We recommend future studies to evaluate the political implications of these social media platforms once data becomes available. Also, it was challenging to access time series data for social media variables, limiting our study to utilize a cross-sectional approach. We, therefore, recommend future studies to deploy time series and panel data techniques to re-examine the linkage between social media and political institutions. Finally, while this study mainly examined the effect of social media on political institutions (democracy), future studies will contribute to the literature if they examine the role of political institutions on social media usage across the globe. Notwithstanding these limitations, our study has contributed to the ongoing debate on the political implications of social media penetration with its novel analytical approaches.

6 Appendix

See Tables 6, 7, 8, 9, 10 and 11; Figs. 5, 6, 7, 8 and 9.

Table 6 Study sample

Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, China, Colombia, Comoros, Costa Rica, Croatia, Cyprus, Denmark, Djibouti, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Lebanon, Lesotho, Libya, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Rwanda, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovenia, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Tajikistan, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Vanuatu, Vietnam, Zambia

Table 7 Effect of social media on electoral democracy

Variable of interest	Social media	Number of observations	128
Outcome variable	Electoral democracy	Mean R-squared	0.46
Possible control terms	6	Multicollinearity	0.72
Number of models	64		
Model robustness statistics		Significance testing	(%)
Mean (b)	0.0657	Sign Stability	100
Sampling SE	0.0130	Significance rate	100
Modelling SE	0.0242		
Total SE	0.0275	Positive	100
		Positive and Sig	100
Robustness ratio	2.3901	Negative	0
		Negative and Sig	0
Model Influence	Marginal effect of variable inclusion	Percent change from mean (b)	(%)
Internet	-0.0418		-63.7
Mobile phone	0.0151		22.9
Natural resources rent	-0.0096		-14.6
GDP per capita	-0.0076		-11.6
Trade openness	0.0017		2.5
Years of schooling	0.0002		0.3
Constant	0.0867		
R-squared	0.9222		

Table 8 Effect of social media on Liberal democracy

Variable of interest	Social Media	Number of observations	128
Outcome variable	Liberal democracy	Mean R-squared	0.52
Possible control terms	6	Multicollinearity	0.72
Number of models	64		
Model robustness statistics		Significance testing	(%)
Mean (b)	0.0584	Sign Stability	100
Sampling SE	0.0128	Significance rate	75
Modelling SE	0.0313		
Total SE	0.0338	Positive	100
		Positive and Sig	75
Robustness ratio	1.7258	Negative	0
		Negative and Sig	0
Model influence	Marginal effect of variable inclusion	Percent change from mean (b)	(%)
Internet	-0.0555	-95.0	
GDP per capita	-0.0147	-25.2	
Mobile phone	0.0133	22.8	
Natural resources rent	-0.0094	-16.2	
Trade openness	0.0016	2.7	
Years of schooling	0.0002	0.3	
Constant	0.0906		
R-squared	0.9231		

Table 9 Effect of social media on participatory democracy

Variable of interest	Social media	Number of observations	128
Outcome variable	Participatory democracy	Mean R-squared	0.46
Possible control terms	6	Multicollinearity	0.72
Number of models	64		
Model robustness statistics		Significance testing	(%)
Mean (b)	0.0457	Sign Stability	100
Sampling SE	0.0104	Significance rate	75
Modelling SE	0.0224		
Total SE	0.0247	Positive	100
		Positive and Sig	75
Robustness ratio	1.8520	Negative	0
		Negative and Sig	0
Model influence	Marginal effect of variable inclusion	Percent change from mean (b)	(%)
Internet	-0.0393		-85.9
Mobile phone	0.0122		26.8
GDP per capita	-0.0087		-19.1
Natural resources rent	-0.0076		-16.6
Trade openness	0.0016		3.6
Years of schooling	0.0006		1.4
Constant	0.0662		
R-squared	0.9274		

Table 10 Effect of social media on deliberative democracy

Variable of interest	Social media	Number of observations	128
Outcome variable	Deliberative democracy	Mean R-squared	0.47
Possible control terms	6	Multicollinearity	0.72
Number of models	64		
Model robustness statistics		Significance testing	(%)
Mean (b)	0.0533	Sign Stability	100
Sampling SE	0.0120	Significance rate	88
Modelling SE	0.0260		
Total SE	0.0287	Positive	100
		Positive and Sig	88
Robustness ratio	1.7493	Negative	0
		Negative and Sig	0
Model influence	Marginal effect of variable inclusion	Percent change from mean (b)	(%)
Internet	-0.0454		-85.3
GDP per capita	-0.0119		-22.3
Mobile phone	0.0113		21.1
Natural resources rent	-0.0092		-17.3
Trade openness	0.0016		3.1
Years of schooling	-0.0002		-0.4
Constant	0.0803		
R-squared	0.9090		

Table 11 Effect of social media on Egalitarian democracy

Variable of interest	Social media	Number of observations	128
Outcome variable	Egalitarian democracy	Mean R-squared	0.54
Possible control terms	6	Multicollinearity	0.72
Number of models	64		
Model robustness statistics		Significance testing	(%)
Mean (b)	0.0376	Sign stability	100
Sampling SE	0.0123	Significance rate	50
Modelling SE	0.0326		
Total SE	0.0349	Positive	100
		Positive and sig	50
Robustness ratio	1.0771	Negative	0
		Negative and sig	0
Model influence	Marginal effect of variable inclusion	Percent change from mean (b)	(%)
Internet	-0.0571	-152.0	
GDP per capita	-0.0177	-47.2	
Mobile phone	0.0109	29.1	
Natural resources rent	-0.0094	-25.0	
Trade openness	0.0013	3.3	
Years of schooling	0.0008	2.2	
Constant	0.0732		
R-squared	0.9022		

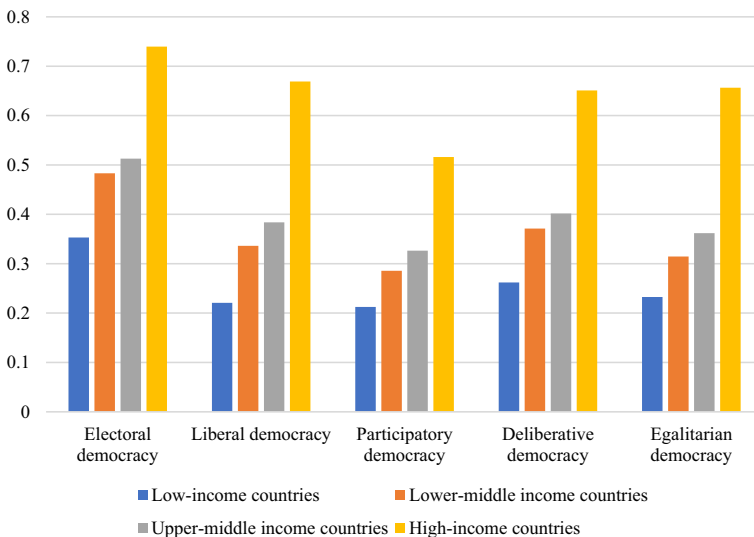


Fig. 5 Democracy across income groups

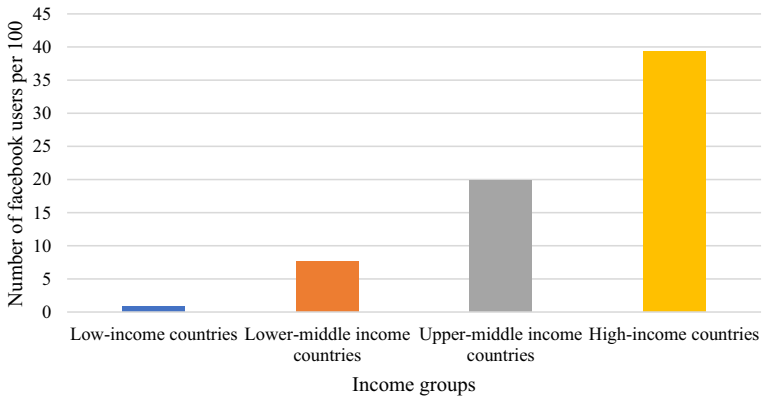


Fig. 6 Facebook penetration across income groups

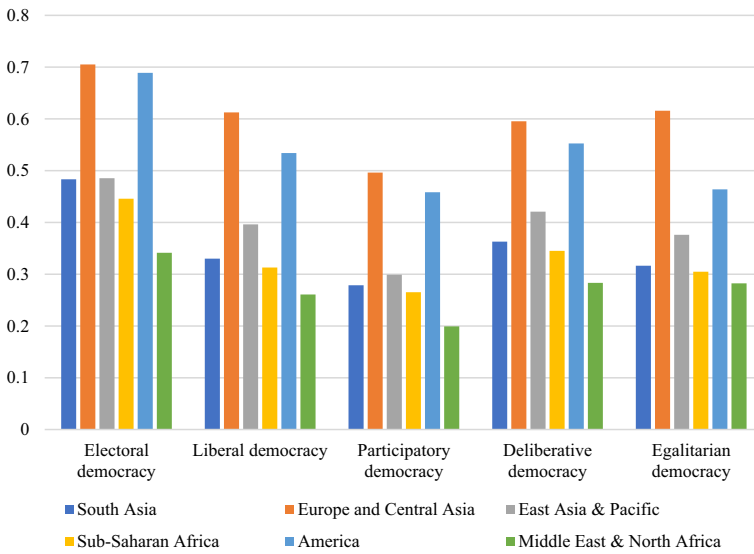


Fig. 7 Democracy across regional groups

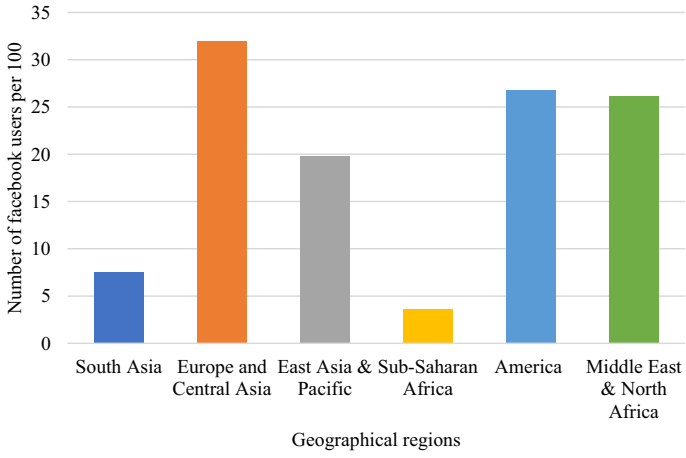


Fig. 8 Facebook penetration across regional groups

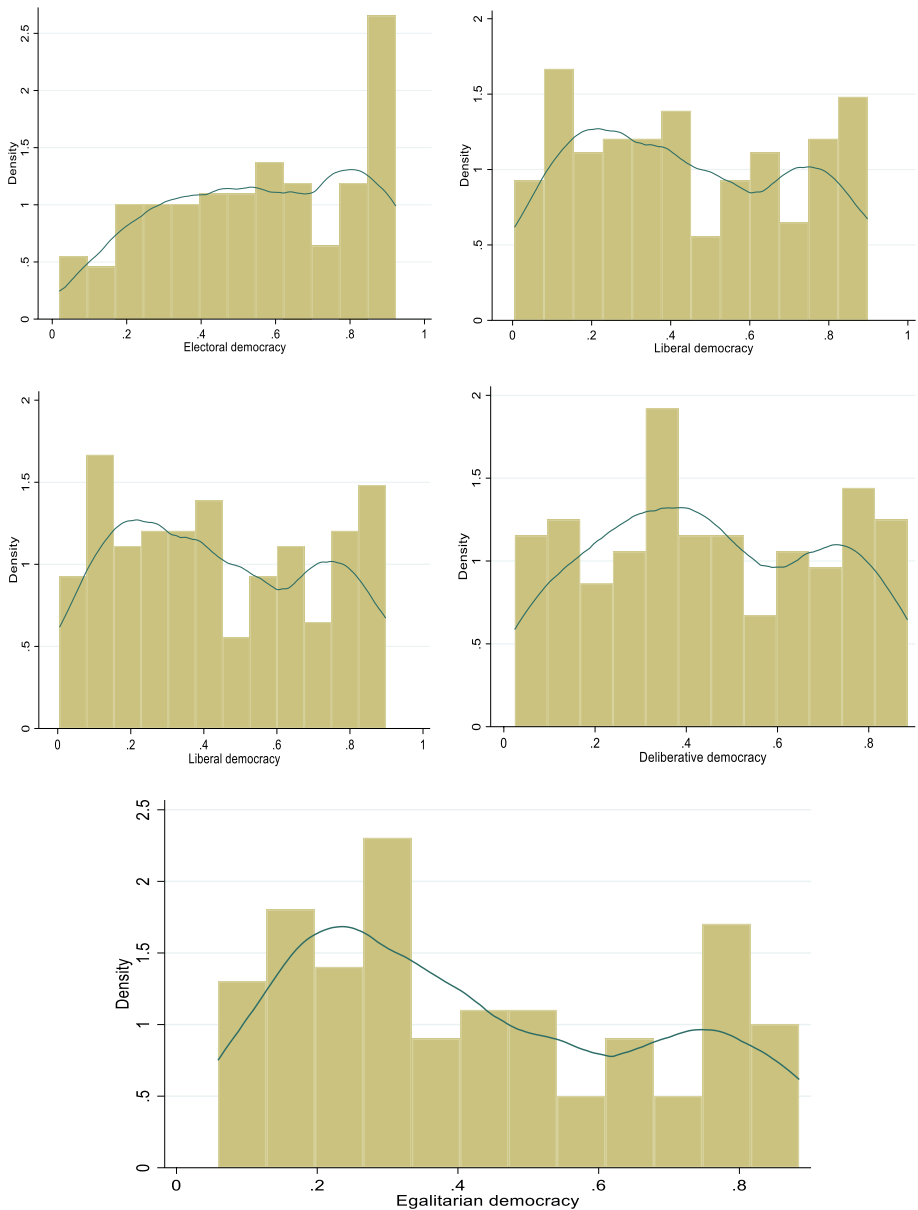


Fig. 9 Distribution of the democracy variables

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Declarations

Conflict of interest The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval This article does not contain any studies with animals and human participants performed by the authors.

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