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# THE ROLE OF SOCIAL CAPITAL AND SOCIAL INNOVATION IN ECONOMIC GROWTH

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## ABSTRACT

The study assessed the role of social capital and social innovation in economic growth. Nonetheless, a panel of 147 countries was sampled from 2009 to 2017, and econometric panel techniques were utilized to arrive at a statistical conclusion. The techniques used in the estimation are contemporaneous correlation estimators; thus, panel corrected standard errors, panel generalized least square with correlation disturbances, and generalized linear model. Upon estimations, the study concluded that social capital and social innovation strongly play a positive role in economic growth. Therefore, in pursuit of sustainable economic growth, social capital accumulation; thus, social trust and social networking are essential. Moreover, social innovations that are internet-related positively contribute to economic growth sustainably. The study recommends that investment in digital communication technologies should be prioritized because it improves material living standards because it lowers the cost of maintaining and creating professional and personal ties, strengthening the diffusion of knowledge and ideas, and further creating productivity spill overs positively. Also, policymakers should enact policies that offer triple triumph; thus, triumph for government, society, and individuals characterised by affordability, benefits, and add value to citizens' standard of living.

**Contribution/Originality:** The paper contributes the first logical analysis of the role of social capital and social innovation in economic growth. With a panel of 147 countries and period from 2009 to 2017, and econometric panel techniques utilized, the study concludes that social capital and social innovation strongly play a positive role in economic growth.

## 1. INTRODUCTION

From a macroeconomic perspective, social capital is the shared good that entails a trust-based network and trust itself, thereby improving economic policies' effectiveness (Easterly & Levine, 1997). According to Uzzi (1996), trust-based networks ensure the transmission and transfer of varied, reliable, and essential information. Perhaps, information sharing is considered as the fundamental ingredient for innovation. In support of this assertion, Akçomak and Ter Weel (2009) contend that facilitating cooperation, interaction, and information sharing result in creating social capital that encourages innovation undertakings, whereas affecting economic growth positively. In most emerging and industrialized economies, innovation has been deciphered as the fuel for growth, especially in countries like the United Kingdom, Finland, Austria, Sweden, and the United States became heavily innovative between 1995 and 2006 when they aimed to become innovative economies. Innovation is referred to as introducing

231

a new service or product, method or process; unlike the previous times, when academically researchers formed to undertake technological and scientific research and development activities exclusively were referred to as innovation (Oslo-Manual, 2005). According to Dovey (2009), innovation encompasses a growing cost and complexity demand for burgeoning levels of information sharing and cooperation among innovators in a multi-disciplinary context. Consequently, social capital is accumulated in that process through trust based on collaborative learning, idea, and creative implementation. Over the past decade, the interest in social innovation has surged phenomenally in pursuit of economic growth in a sustainable manner (Urama & Acheampong, 2013). This is due to the desperate need for a massive transformation of economic, social, and cultural engagements. However, the old paradigm of government assistance is considered outmoded and not sufficient to meet these demands. Ultimately, innovative and creative solutions are needed to ensure job security and competition among businesses to foster sustainable economic growth (Urama & Acheampong, 2013). With new ideas and innovations emanated from social innovations such as distance learning, fair trade, restorative justice, mobile money transfer, and zero-carbon housing, social innovation seeks to address many of the world's most serious problems. There are also fundamentally evolving values, basic practices, social power structures, and resources to develop solutions. Social innovation offers a wide range of opportunities to step back from a narrow way of thinking about social enterprises, corporate involvement, and philanthropic work and consider the interrelatedness of different factors and stakeholders. Empirically, scores of studies have observed a positive relationship between economic growth and social capital on the macroeconomic level; most of these studies used trust as a proxy measure of social capital (Bertrand, Luttmer, & Mullainathan, 2000; Bjørnskov, 2006; Miguel, 2003; Ostrom, 2000; Sobel, 2002; Tau, 2003). In pursuit of sustainable economic growth, Jones (1995); Jones (2002) argued that innovation plays a crucial role and serves as the engine and fuel for growth when innovators' output-workers significantly increase.

To the best of the author's knowledge, this present study is the first attempt to empirically assess the role of social capital and social innovation in economic growth by considering the macro-level of social trust using institutional quality indicators and also social media penetration to measure social networking; all as measures of social capital. A plethora of studies have theoretically modeled the relationship between social capital, innovation, and economic growth (Sequeira & Ferreira-Lopes, 2013; Thompson, 2018), but no empirical study has yet been conducted the global context. However, this present study intends to empirically understand the role that social capital and innovation play in economic growth by employing the endogenous growth model proposed by Thompson (2018) on the endogenous growth theory's backdrop. Moreover, econometric techniques are employed to statistically and empirically understand this phenomenon, such as the contemporaneous correlation estimators.

The other sections of the study are categorized as follows: "' **theoretical underpinning**" describes the theoretical basis of the study, **"empirical methodology and data"** highlights on the econometric approaches and method of analysis, and data source as well as variables description, **"Presentation of results and discussion"** presents the findings and discussion of results, **"conclusion and policy implication"** summarises the study and proposes recommendations for policy direction.

## 2. THEORETICAL UNDERPINNING

Sequeira and Ferreira-Lopes (2013) propound the first endogenous growth model linking social capital and innovation together with economic growth, whereas the study incorporated human capital and social capital, research and development expenditure into the model. In light of the findings, the study contended that social capital positively contributes to innovation, significantly impacting economic growth. In furtherance to their proposal, Thompson (2018) argued that the relationship between social capital and economic growth are innovative related. Therefore, in an innovation-related and technologically advanced economy, social capital and innovation are endogenous to economic growth. The study's argument is premised because social capital accumulation is characterised by the aggregate production function that is endogenously determined by intermediate inputs

through a two-sector, non-scale, and idea-based growth model with complementarities. Moreover, in an innovative styled economy, innovators' ability to cooperate and share their innovation yields higher innovation output, translating into higher aggregate output in the economy. Fundamentally, the ability to cooperate and share innovative ideas and products rely on trust-based networks and trust in the circles; hence, the stock of social capital with the economy. In view of this, the study proposed that the endogenous growth model should encompass social and physical capital, the aggregate production of output, free flow of goods and services, labor involvement, knowledge accumulation, and innovation. Upon this assumption, this present study adopts the endogenous growth model for its empirical analysis. The theoretical model for the endogenous production function can be found as:

$$Y = AK, . a_i \ L^{1-a} \ i \ K^{\beta} \tag{1}$$

The assumption is that, for simplicity's sake, all industries are symmetrically related. Therefore, every industry employs the same number of labor and amount of capital. Subsequently, then the aggregate production function can be found as:

$$Y_t = AK^{a} \ L\beta \tag{2}$$

Whereas;

Y = aggregate output (economic growth: measured by gross domestic product per capita).

A = TFP (Total factor productivity- which measures the efficiency level of input factors).

K = physical and human capital accumulation (capital stock).

L = Labour participation in the economy.

To simplify the Equations 1 and 2, both equations are endogenous because the residual components are also endogenous; thus, A measures the technological advancement level. Also, α and β denote the elasticity outputs or coefficients of factor inputs of capital and labor. To subject this model to this present study's assumption, the endogenous growth model incorporates social capital (social trust and social networks), social innovation, physical and human capital accumulation, the openness of the economy, and labor participation are predominantly the crucial factors for economic growth. Therefore, the assumption is that social capital and innovation impact growth through the efficient use of inputs, which relatively depend on the openness of the economy and total factor productivity. Hence;

$$A = (\text{Social capital, Social innovation, Technology, Openness}) \tag{3}$$

However, Equation 3 posits that factor inputs used to measure an economy's efficiency level are reliant on social capital, social innovation, technological advancement, and openness of the economy. In contrast, social capital and social innovation could contribute significantly to economic growth through advancement in technology, improvement in human capital, and increase in capital stock (Ajayi, 2006; Ozekhome, 2017; Vitenu-Sackey., 2020). Moreover, most countries enjoy positive spillovers due to their absorptive capabilities in relation to the gains from the openness of their economy, investment in human capital, etc. Based on the endogenous growth model, the empirical model constructed for this study can found below: (see appendix Table 9 for variables' descriptions)

$$\text{GDPCAP} = f \ (\text{SMP, IQ, Patent, MCS, FBS, IntUsers, SIS, GCF, SET, L, TRADE}) \tag{4}$$

Therefore, the econometric model for the study is as follows:

$$lnGDPCAP_{i,t} = \beta_0 + \beta_1 \ Social \ Capital_{i,t} \begin{pmatrix} SMP \\ IQ \end{pmatrix} + \beta_2 \ Social \ Innovation_{i,t} \begin{pmatrix} lnPATENT \\ lnINTUSERS \\ lnMCS \end{pmatrix} + \beta_3 \ (lnFBS)_{i,t}$$

$$+ \beta_4 \ (lnSIS)_{i,t} + \beta_5 \ (lnGCF)_{i,t} + \beta_6 \ (lnSET)_{i,t} + \beta_7 \ (lnL)_{i,t} + \beta_8 \ (lnTRADE)_{i,t}$$

$$+ \ \varepsilon_{i,t} \tag{5}$$

In Equation 5, social capital has two proxy measures, thus social media (network) penetration (SMP) and institutional quality (IQ - measuring social trust), social innovation measured by proxy of patent registration, internet usage, and mobile cellular subscription. lnGDPCAP represents economic growth (gross domestic product per capita), lnFBS stands for fixed broadband subscription, lnSET stands for school enrolment in tertiary education, lnSIS stands for secured internet servers, L stands for labor participation, lnGCF stands for gross capital formation, and lnTrade represent openness of an economy. The indicators $\beta_1$ to $\beta_8$ represent the coefficients of the parameters to be estimated, $\beta_0$ represent the constant term or intercept slope, $\varepsilon$ represents the error term or stochastic disturbance in the model, whereas i represents the cross-section of 147 countries sampled, and t represents the sample period from 2009 to 2017.

## 3. EMPIRICAL METHODOLOGY AND DATA

### 3.1. Empirical Methodology

The econometric procedure used to estimate the long-run parameters of the proposed model can be found as (i) cross-sectional dependence test (Pesaran, 2004) to ascertain the heterogeneous slopes and residual cross-sectional dependence amid the panels, (ii) panel unit root tests thus LLC, IPS, ADF, and PP Fischer chi-square unit root tests (Im, Pesaran, & Shin, 2003; Levin, Lin, & Chu, 2002; Maddala, Wu, & Liu, 1999) after evidence of cross-sectional dependence have been ascertained. Usually, ascertaining cross-sectional dependence requires unit root tests to check the stationarity level of the variables, (iii) after the unit root tests, panel cointegration tests are performed to decipher the long-run connection among the selected variables. Hence, Johansen Fischer combined, and Kao cointegration tests were performed. Subsequently, the long-run estimations are performed with panel corrected standard errors (PCSE), generalized least square with correlated disturbances (GLS), and generalized linear model (GLM). The panel corrected standard errors estimator resolve the issue of heteroskedasticity consistency in the standard errors of the variables in the model (Greene, 2000). Since most of the variables could not pass the cross-sectional dependence test, it becomes necessary to use an estimator to resolve the issue because the error terms of those variables could not depict dependence in the individual cross-sections. Using the GLS, the study intends to estimate the unknown parameters in the panel that would be correlated because some independent variables depicted high correlation coefficients with the dependent variable. However, GLS is the best estimator to resolve the problem of autocorrelation disturbances and serial correlation. Koreisha and Fang (2001) observed that the estimator could correctly identify inefficiently estimated parameters in the procedure. Moreover, for the sake of robust inference, the generalized linear model (GLM) is used. This estimator is a flexible generalization of ordinary linear regression that does not permit response variables with a normal distribution other than error distribution models. The generalized linear model simplifies linear regression by permitting the linear model to be associated with the response variable through a link function and permitting the size of each measurement's variance to be a function of its predicted value. Finally, the direction of causal relationships is assessed with the Granger causality test. In pursuit of the directions, two directions are expected; bidirectional and unidirectional.

### 3.2. Data

The study used data collected from the World Development Indicators, World Bank from 2009 to 2017 for a panel of 147 countries. The dependent variable is economic growth measured by proxy of gross domestic product per capita, and the independent variables are social capital and social innovation. Social capital is measured by proxy of institutional quality (the aggregate average scores of corruption control, political stability, voice and accountability, the rule of law, government effectiveness, and regulatory quality) to represent social trust and social network/media penetration (average penetration rate of four major social networks; Twitter, Facebook, Pinterest,

and YouTube) (Vitenu-Sackey & Hongli, 2020). Putnam (1993) contends that citizens' engagement in voting, voluntary associations, and civic engagement necessitate social capital and social trust. Therefore, repeated engagement enables a smooth flow of communication and information dissemination, which in turn leads to cooperation and trustworthiness, leading to a reduction in transaction costs surrounding economic activities. However, public institutions' role in economic transformation is crucial and dependent on the quality of services provided to the public to ensure trust (Hongli & Vitenu-Sackey, 2020; Vitenu-Sackey & Alhassan, 2019). Social innovation is measured by proxy of internet usage, patent registration, and mobile cellular subscriptions. Some variables are used as control variables but are endogenous in the growth model, such as fixed broadband subscription, gross capital formation, trade openness, secured internet servers, tertiary education enrolment rate, and labor participation (see Table 9 in the appendix for more details).

## 4. PRESENTATION OF RESULTS AND DISCUSSION

### 4.1. Results

#### 4.1.1. Summary Statistics and Sample Adequacy Test

Table 1 exhibits the outcome of the summary statistics of the selected variables for the study. The summary statistics of the variables emanate from 147 sampled countries for the period 2009 to 2017. Evidence from Table 1 suggests that the data series is not normally distributed based on the skewness, kurtosis, and Jarque-Bera tests. Averagely, gross capital formation (lnGCF) reported the highest mean, thus 22.843% with a standard deviation of 4.394%. The variable that reported the second highest mean value is economic growth, thus 8.694% with a standard deviation of 1.487%. Mobile cellular subscriptions reported the third-highest mean value (M=4.534%, SD =0.536) followed by trade openness (lnTRADE, M= 4.365%, SD= 0.517%). Labour participation rate (lnL) and patent registrations (lnPatent) had mean values of 4.219% and 3.849% with standard deviations of 0.162% and 3.468%, respectively (see Table 1 for other variables). The explanation of gross capital formation chalking the highest mean could be credited to the aggregate demand for physical capital accumulation through investments from the private and public sectors. Suffice to this, labour participation, innovation, and trade liberalization have contributed enormously to output, as depicted in the summary statistics.

**Table-1.** Summary statistics.

|  | LNGDPCAP | LNSMP | LNPATENT | LNMCS | IQ | LNFBS |
|---|---|---|---|---|---|---|
| Mean | 8.694 | 1.596 | 3.849 | 4.534 | 0.082 | 1.150 |
| Std. Dev. | 1.487 | 0.596 | 3.468 | 0.536 | 0.931 | 2.379 |
| Skewness | -0.068 | -1.010 | 0.440 | -2.606 | 0.619 | -1.032 |
| Kurtosis | 2.028 | 4.473 | 2.288 | 18.443 | 3.284 | 3.168 |
| Jarque-Bera | 53.092 | 344.559 | 70.652 | 14644.230 | 88.923 | 236.476 |
| Probability | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Observations | 1323 | 1323 | 1323 | 1323 | 1323 | 1323 |
|  | LNGCF | LNL | LNSET | LNSIS | LNTRADE | LNINTUSERS |
| Mean | 22.843 | 4.219 | 2.922 | 3.611 | 4.365 | 3.437 |
| Std. Dev. | 4.394 | 0.162 | 1.450 | 3.120 | 0.517 | 1.068 |
| Skewness | -3.918 | -0.981 | -0.917 | 0.174 | 0.299 | -1.274 |
| Kurtosis | 21.172 | 3.560 | 2.620 | 2.007 | 3.707 | 4.055 |
| Jarque-Bera | 21589.540 | 229.387 | 193.171 | 61.021 | 47.184 | 419.311 |
| Probability | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Observations | 1323 | 1323 | 1323 | 1323 | 1323 | 1323 |

In Table 2, the outcome from the principal component analysis is displayed. Specifically, KMO and Bartlett's test and scree-plot of factor analysis are presented. The outcome suggests that the components extracted explain 81.96% of the variance as the maximum amount, whereas each had an Eigenvalue greater than 1 (see Figure 1).

Regarding the KMO and Bartlett's test, the outcome suggests that the sample is adequate and falls within the adequacy threshold.

**Table-2.** Sample adequacy test.

| KMO and Bartlett's Test | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.884 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 9042.789 |
| | df | 66 |
| | Sig. | 0.000 |
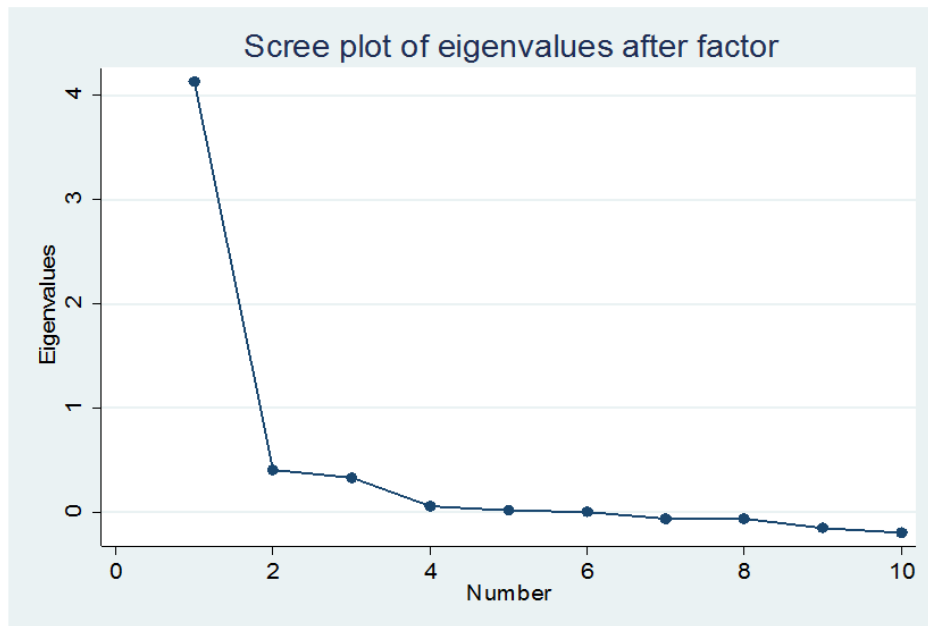


**Figure-1.** Scree-plot showing extracted components using eigenvalues.

### 4.1.2. Unit Root and Cross-Sectional Dependence Tests

Table 3 presents the results of the cross-sectional dependence test and unit root tests. Evidence from the cross-sectional dependence test outlines that four (4) out of the twelve (12) variables could not substantiate evidence of cross-sectional dependence; thus, lnSET, lnGCF, lnPATENT, and lnSIS. In essence, Pesaran cross-sectional dependence test was utilized (Pesaran, 2004). Apart from those four (4) variables, all other eight (8) variables showed cross-sectional dependence at a 1% significance level. This outcome implies that the panel data of lnSET, lnGCF, lnPATENT, and lnSIS do not postulate dependence of their error terms in the cross-sections individually, but the other variables confirm otherwise. Apparently, the cross-sectional dependence test's outcome informs the adoption of an econometric methodology that could resolve that issue. In furtherance, unit root tests were performed to unravel the stationarity levels of the variables. However, four (4) unit root tests were performed; thus, Maddala et al. (1999) test, Im et al. (2003) test, and Levin et al. (2002) test. At level form, the null hypothesis of unit root could not be rejected; therefore, the tests were performed at the first difference. However, at the first difference, the null hypothesis was rejected at a 1% and 5% significance level for all the variables, respectively. The outcome implies that at differenced, all the series in the presence of heterogeneity and cross-sectional correlations follow the same order of integration (I(1)) and are non-stationary.

**Table-3.** Panel unit root tests and cross-sectional dependence test.

| | Level form | | | | First Difference | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | LLC | IPS | ADF-Fisher | PP-Fisher | LLC | IPS | ADF-Fisher | PP-Fisher | Pesaran CD |
| lnGDPCAP | –8.461*** | 1.196 | 386.098*** | 512.979*** | –35.469*** | –11.833*** | 663.355*** | 669.369*** | 166.455*** |
| IQ | –6.897*** | 1.096 | 295.963 | 287.604 | –29.798*** | –11.929*** | 698.632*** | 857.477*** | 3.553*** |
| lnFBS | –26.261*** | –12.025*** | 655.708*** | 908.629*** | –90.062*** | –20.478*** | 788.637*** | 894.592*** | 210.189*** |
| lnGCF | –44.776*** | –9.667*** | 433.382*** | 573.016*** | –13.041*** | –11.548*** | 683.884*** | 835.262*** | |
| lnINTUSERS | –24.690*** | –4.619*** | 518.094*** | 799.235*** | –23.764*** | –17.985*** | 825.999*** | 1014.95*** | 279.832*** |
| lnL | –5.621*** | 0.221 | 397.299*** | 461.216*** | –32.134*** | –11.812*** | 706.545*** | 809.767*** | 21.245*** |
| lnMCS | –32.067*** | –13.569*** | 704.636*** | 947.149*** | –42.095*** | –13.692*** | 714.653*** | 775.103*** | 113.423*** |
| lnPATENT | –18.972*** | –5.121*** | 379.304*** | 478.499*** | –33.584*** | –13.996*** | 677.978*** | 871.579*** | |
| lnSET | –60.178*** | –39.829*** | 638.573*** | 695.074*** | –111.673*** | –40.063*** | 711.130*** | 808.777*** | |
| lnSIS | –20.965*** | –2.920** | 630.627*** | 861.021*** | –154.152*** | –57.155*** | 1610.52*** | 1932.02*** | |
| lnSMP | –22.745*** | –8.456*** | 562.368*** | 259.240 | –20.131*** | –8.416*** | 575.412*** | 338.489** | 162.604*** |
| lnTRADE | –19.072*** | –6.304*** | 518.658*** | 655.914*** | –23.650*** | –8.931*** | 588.105*** | 716.646*** | 56.140*** |

**Note:** *** denote 1% significance level, ** denote 5% significance level.

### 4.1.3. Cointegration tests

The Cointegration test reveals the long-run connection among variables selected for a study, specifically the dependent and independent variables. In accord with the cointegration test, Johansen Fischer unrestricted tests (Trace and Max-Eigen) and the Kao test were computed. The Johansen Fischer tests' outcome suggests that there is evidence of a cointegration relationship in both trace and Max-Eigen tests; hence, the variables selected for the study have a long-run relationship. Suffice it to this; the Kao test also postulated that all the variables are cointegrated at a 1% significance level. Therefore, at 1% and 5% significance levels, the null hypothesis of cointegration is strongly rejected (see Table 4 for details).

**Table-4.** Panel cointegration test.

| Johansen Fischer Unrestricted Cointegration Rank Test | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hypothesized | Trace | | | Hypothesized | Max-Eigen | | |
| No. of CE(s) | Statistic | Prob.** | Sig. | No. of CE(s) | Statistic | Prob.** | |
| None * | 762.419 | 0.000 | *** | None * | 244.660 | 0.000 | *** |
| At most 1 * | 517.759 | 0.000 | *** | At most 1 * | 133.487 | 0.000 | *** |
| At most 2 * | 384.272 | 0.000 | *** | At most 2 * | 92.443 | 0.000 | *** |
| At most 3 * | 291.829 | 0.000 | *** | At most 3 * | 80.002 | 0.000 | *** |
| At most 4 * | 211.827 | 0.000 | *** | At most 4 * | 78.182 | 0.000 | *** |
| At most 5 * | 133.644 | 0.015 | ** | At most 5 * | 51.291 | 0.013 | ** |
| At most 6 | 82.354 | 0.290 | | At most 6 * | 42.792 | 0.024 | ** |
| Kao Residual Cointegration Test | | | | | | | |
| | t-Statistic | Prob. | Sig. | | | | |
| ADF | -5.271 | 0.000 | *** | | | | |

**Note:** *** denote 1% significance level, ** denote 5% significance level, * denote 10% significance level.

### 4.1.4. Correlation Matrix

The correlation matrix computed at this juncture objects to reveal two critical econometric diagnoses report: (1) correlation association between the dependent and the independent variables, and (2) evidence of multicollinearity. According to Sun, Tong, and Yu (2002), when two or more independent variables exhibit correlation coefficients of -/+0.70 or more with the dependent variable, then the model in which the estimation is expected to be done would experience multicollinearity. Therefore, this present study performed a multicollinearity test with the aid of the correlation matrix. From the outcome presented in Table 5, it is evidenced that four (4) independent variables (lnSIS, lnINTUSERS, IQ, and lnFBS) had correlation coefficients more than the accepted threshold of -/+0.70 specifically, 0.734, 0.829, 0.771 and 0.829, respectively. This implies that those variables are highly correlated with lnGDPCAP; in other words, economic growth. To resolve this high correlation issue per the proposed model, the contemporaneous correlation estimators would be employed.

On the other hand, it was observed that all the independent variables are positively and significantly correlated to the dependent variable at a 1% significant level consistently.

**Table-5.** Correlation matrix.

| Correlation<br>Probability | ln<br>GDPCAP | ln SMP | ln<br>PATENT | ln MCS | IQ | ln<br>FBS | ln<br>GCF | ln L | ln SET | ln SIS | ln<br>TRADE | ln<br>INTUSERS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lnGDPCAP | 1 | | | | | | | | | | | |
| lnSMP | 0.302*** | 1 | | | | | | | | | | |
| lnPATENT | 0.538*** | 0.228*** | 1 | | | | | | | | | |
| lnMCS | 0.524*** | 0.142*** | 0.234*** | 1 | | | | | | | | |
| IQ | 0.771*** | 0.212*** | 0.429*** | 0.402*** | 1 | | | | | | | |
| lnFBS | 0.829*** | 0.267*** | 0.578*** | 0.585*** | 0.668*** | 1 | | | | | | |
| lnGCF | 0.347*** | 0.092*** | 0.431*** | 0.189*** | 0.192*** | 0.308*** | 1 | | | | | |
| lnL | 0.182*** | 0.135*** | 0.078** | -0.031 | 0.256*** | 0.100*** | 0.012 | 1 | | | | |
| lnSET | 0.414*** | 0.120*** | 0.374*** | 0.356*** | 0.352*** | 0.518*** | 0.167*** | -0.087** | 1 | | | |
| lnSIS | 0.734*** | 0.216*** | 0.442*** | 0.506*** | 0.650*** | 0.740*** | 0.248*** | 0.210*** | 0.420*** | 1 | | |
| lnTRADE | 0.301*** | 0.106*** | -0.105*** | 0.306*** | 0.315*** | 0.297*** | -0.106*** | 0.119*** | 0.178*** | 0.313*** | 1 | |
| lnINTUSERS | 0.829*** | 0.198*** | 0.522*** | 0.616*** | 0.635*** | 0.867*** | 0.255*** | 0.044 | 0.485*** | 0.755*** | 0.263*** | 1 |

**Note:** *** denote 1% significance level, ** denote 5% significance level, * denote 10% significance level.

To assess the role of social capital and social innovation in economic growth, the study constructed four (4) models to aid that objective. Model 1 takes into account the role of social capital in economic growth; model 2 considers the role of social innovation in economic growth, model 3 assesses the interaction of internet usage with social innovation proxies (patent and mobile cellular subscription), and model 4 highlights on the combined effects of social capital and social innovation on economic growth. Due to the inability of four (4) variables to show cross-sectional dependence based on the Pesaran CD test, the error terms could not depict dependence in the individual cross-sections; hence the use of panel corrected standard errors estimator to resolve that issue. Upon estimating the long-run parameters of the selected variables for the study, Table 6 presents the outcome.

In model (1), it can be reported that social capital positively contributes to economic growth. Specifically, the two proxy measures of social capital (lnSMP and IQ) showed a positive and significant role in economic growth. More specifically, social networks (lnSMP) showed an elasticity coefficient magnitude of 0.173 and a positive sign. This implies that a percentage point increase in social networks could increase economic growth by 0.173% at a 1% significance level. Also, institutional quality as a proxy measure of social trust and social capital showed an elasticity magnitude of 0.554, implying that a percentage increase in institutional quality (social trust) could increase economic growth by 0.554% at a 1% significance level. A fixed broadband subscription, secured internet servers, and gross capital formation (capital stock) positively intervene in the relationship between social capital and economic growth. However, a percentage increase in fixed broadband subscription could increase economic growth by 0.283% at a 1% significance level. On the other hand, a percentage increase in secured internet servers and gross capital formation could increase economic growth by 0.065% and 0.036% at 1% and 5% significance level, respectively.

With respect to model 2, where social innovation in economic growth is considered, only one out of three proxy measures of social innovation showed a significant role in economic growth. Perhaps, internet usage plays a significant role in economic growth, as revealed by this analysis's outcome. Specifically, internet users (lnINTUSERS) depict an elasticity coefficient of 0.578, implying that a percentage increase in internet usage could increase economic growth by 0.587% at a 1% significance level. The relationship between internet users (lnINTUSERS) as a proxy measure of social innovation and economic growth is positively intervened by fixed broadband subscription, gross capital formation, secured internet servers, labour participation, and trade liberalization (openness). Since the other proxy measures of social innovation (lnPATENT and lnMCS) depicted an insignificant role in economic growth in model 2, in furtherance, model 3 was constructed to incorporate the interaction relationship between lnMCS (mobile cellular subscribers) and internet users (lnINTUSERS); hence, lnMCS*lnINTUSERS. Also, the interaction between patent registration (lnPATENT) and internet users (lnINTUSERS); hence, lnPATENT*lnINTUSERS. This is due to internet-based innovation being established as a catalyst for technological effect on economic growth. Therefore, in model 3, it is evidenced that the interaction between patent registration and internet users positively and significantly contributes to economic growth and the interaction between mobile cellular subscriptions. Specifically, with an elasticity coefficient magnitude of 0.067, a percentage increase in internet-based innovation in the form of patent registrations (lnPATENT*lnINTUSERS) could lead to an increase in economic growth by 0.067%. Considering the interaction between mobile cellular subscription and internet usage, it is evidenced that innovations based on mobile cellular subscription with the aid of the Internet could increase economic growth by 0.194% at a percentage point increase due to its elasticity coefficient magnitude of 0.194. In that event, fixed broadband subscription, gross capital formation, and trade openness should incentivize economic growth because they positively intervene in the relationship between internet-based social innovation and economic growth.

Interestingly, when the interaction between internet usage and patent registration and mobile cellular subscription are considered, ordinary internet usage plays an insignificant role in economic growth. More so,

mobile cellular subscription and patent registration negatively and significantly contribute to economic growth. This indicates that innovations that are not internet-based play an inverse role in economic growth. The study further constructed model 4 to incorporate social capital and social innovation to ascertain their role in economic growth in coexistence. In model 4, it is evidenced that social capital proxy measures positively and significantly contribute to economic growth consistent with model 1. Also, social innovation measured with internet-based innovations positively and significantly contributes to economic growth instead of innovation measures of mobile cellular subscriptions and patent registrations that are not internet-based. Perhaps, while internet-based innovations have a positive connection with economic growth, non-internet-based innovations adversely affect economic growth. To account for the elasticity coefficients, lnSMP (social network) showed a coefficient magnitude of 0.190, IQ (social trust) showed a coefficient magnitude of 0.464, lnMCS (mobile cellular subscriptions) showed a coefficient magnitude of -0.510, lnPATENT (patent registrations) showed a coefficient magnitude of -0.150, lnPATENT*lnINTUSERS showed coefficient magnitude of 0.042, lnMCS*lnINTUSERS showed coefficient magnitude of 0.155 and lnINTUSERS showed an insignificant coefficient of -0.088. Specifically, a percentage increase in lnSMP, IQ, lnPATENT*lnINTUSERS and lnMCS*lnINTUSERS could lead to an increase in economic growth by 0.190%, 0.464%, 0.042%, and 0.155%, at a 1% and 5% significance levels, correspondingly. The relationship between social capital, social innovation, and economic growth is significantly affected by fixed broadband subscription and gross capital formation. Whereas a percentage point increase in fixed broadband subscriptions could lead to an increase in economic growth by 0.122%, and a percentage point increase in gross capital formation could lead to an increase in economic growth by 0.036% at a 1% significance level, respectively.

### 4.1.6. Robust Check: Contemporaneous Correlation Regression Analysis (Generalised Least Square Regression with Correlated Disturbances and Generalised Linear Model)

To statistically confirm the outcome of the panel corrected standard errors estimator, generalized least square regression with correlated disturbances estimator, and generalized linear model were employed for robust estimations. Perhaps, the PCSE estimator has a limitation that could be resolve by the GLS regression with correlated disturbances hence its employment. Suffice to that, since the correlation matrix revealed that multicollinearity exists between some independent variables and the dependent variable, the GLS regression with correlated disturbances is highly considered the appropriate method over the PSCE to resolve that issue even though they are all contemporaneous correlation estimators. Furthermore, the generalized linear model estimator is used to robust check the GLS regression with correlated disturbances due to its effectiveness in allowing response variables without normal distribution but having error distribution models to respond to the variances through a link function.

The outcome of the analysis performed with GLS with correlated disturbances produced similar coefficients as the PCSE estimator except for the p-value and the significances that differ. Specifically, in model 1 for the PCSE, it was realized that lnL, lnSET, and lnTRADE showed an insignificant relationship with economic growth per their intervening or endogenous effect between social capital and economic growth. In contrast, in the same model in the GLS regression with correlated disturbances, only lnL showed consistency with the PCSE as an insignificant result. In model 2 for the PCSE, lnSET, lnMCS, and lnPATENT depicted an insignificant relationship with economic growth, but in the GLS with correlated disturbances estimation, none of them showed insignificance. In model 3, where internet-based social innovations were considered, it was realized in the PCSE estimations lnINTUSERS, lnSIS, lnL, and lnL showed an insignificant relationship with the endogenous role between social innovation and economic growth. Nevertheless, in the GLS with correlated disturbances, only lnSIS showed an insignificant relationship with economic growth (lnGDPCAP). However, in model 4, where the combined role of social innovation and social capital is considered, lnTRADE and lnSET showed significance in the GLS with correlated disturbance instead of the PCSE estimation.

**Table-6.** PCSE estimation.

| PCSE | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| lnSMP | 0.173 | | | 0.190 |
| | (3.24)*** | | | (3.88)*** |
| IQ | 0.554 | | | 0.464 |
| | (7.30)*** | | | (6.72)*** |
| lnINTUSERS | | 0.578 | -0.227 | -0.088 |
| | | (6.86)*** | (-0.89) | (-0.38) |
| lnMCS | | -0.040 | -0.625 | -0.510 |
| | | (-0.34) | (-2.50)** | (-2.22)** |
| lnPATENT | | 0.029 | -0.227 | -0.150 |
| | | (1.51) | (-3.17)** | (-2.25)** |
| lnpatent*lnINTUSERS | | | 0.067 | 0.042 |
| | | | (3.63)*** | (2.44)** |
| lnMCS*lnINTUSERS | | | 0.194 | 0.155 |
| | | | (2.92)** | (2.52)** |
| lnFBS | 0.283 | 0.192 | 0.185 | 0.122 |
| | (8.93)*** | (4.96)*** | (4.97)*** | (3.47)*** |
| lnSIS | 0.065 | 0.056 | 0.015 | -0.007 |
| | (4.90)*** | (3.30)*** | (0.90) | (-0.53) |
| lnGCF | 0.036 | 0.036 | 0.033 | 0.036 |
| | (2.94)** | (2.78)** | (2.69)** | (3.22)*** |
| lnL | 0.033 | 0.814 | 0.434 | 0.093 |
| | (0.10) | (2.46)** | (1.35) | (0.31) |
| lnSET | -0.031 | -0.041 | -0.038 | -0.039 |
| | (-0.82) | (-1.07) | (-1.05) | (-1.18) |
| lnTRADE | 0.066 | 0.238 | 0.219 | 0.117 |
| | (0.62) | (2.16)** | (2.11)** | (1.19) |
| Constant | 6.642 | 1.184 | 5.382 | 6.707 |
| | (4.35)*** | (0.75) | (3.03)** | (4.03) |
| R² | 0.797 | 0.775 | 0.795 | 0.838 |
| Wald chi² | 707.79*** | 714.45*** | 824.05** | 974.68*** |
| Autocorrelation | No | No | No | No |
| Observation | 1323 | 1323 | 1323 | 1323 |

**Note:** *** denote 1% significance level, ** denote 5% significance level, * denote 10% significance level. Z-statistics are in parentheses.

Ideally, all the other relationships except the aforementioned sufficed with similar coefficient signs. More importantly, the GLS estimations produced the same results as the GLS regression with correlated disturbances estimations. This statistically substantiates the findings of the study for a robust conclusion. In the event of robust inference, the study's findings suggest that social capital and social innovation positively and significantly contribute to economic growth. To be more specific, social networks (lnSMP) and social trust (IQ) lead to increased economic growth. Per their elasticity coefficient magnitudes, a percentage point improvement in social network and social trust could increase economic growth by 0.190% and 0.510% at a 1% significance level. In light of social innovation, the findings suggest that internet-based innovation positively leads to economic growth but not otherwise. However, a percentage point increase in non-internet-based patent registration and mobile cellular subscriptions could decrease economic growth by 0.150% and 0.510% at a 1% significance level, respectively.

Meanwhile, a percentage point increase in internet-based innovations thus the interaction between internet usage and patent registrations and the interaction between internet usage and mobile cellular subscriptions could lead to an increase in economic growth by 0.042% and 0.155% at a 1% significance level, simultaneously. In essence, fixed broadband subscriptions, gross capital formation, and trade openness positively intervene in the relationship between social capital, social innovation, and economic growth. Whereas a percentage point increase in fixed broadband subscriptions, gross capital formation, and trade openness could increase economic growth by 0.122%, 0.036%, and 0.117% at 1% and 5% significance levels, respectively. These variables can be regarded as the drivers of

social capital, social innovation, and economic growth endogenously. A run-down of the study's findings are displayed in Figure 2, and more details are presented in Table 7.
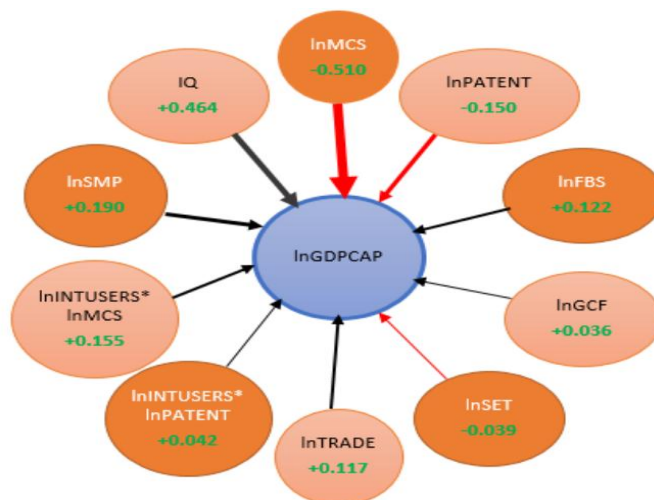


**Figure-2.** Long-run coefficient estimations from generalized least square with correlated disturbances and generalized linear model as robust estimations to panel corrected standard errors estimator. The depth of the arrows depicts the magnitude of the coefficients. The red arrow depicts negative coefficients, and the black arrow depicts positive coefficients

**Table-7.** Robust estimations with generalized least square with correlated disturbances and generalized linear model estimators.

|  | GLS | | | | GLM |
| --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | |
| lnSMP | 0.173 | | | 0.190 | 0.190 |
| | (5.37)*** | | | (6.52)*** | (6.48)*** |
| IQ | 0.554 | | | 0.464 | 0.464 |
| | (19.26)*** | | | (17.42)*** | (17.33)*** |
| lnINTUSERS | | 0.578 | -0.227 | -0.088 | -0.088 |
| | | (14.22)*** | (-1.94)** | (-0.84) | (-0.84) |
| lnMCS | | -0.040 | -0.625 | -0.510 | -0.510 |
| | | (7.16)*** | (-5.40)*** | (-4.94)*** | (-4.92)*** |
| lnPATENT | | 0.029 | -0.227 | -0.150 | -0.150 |
| | | (3.65)*** | (6.98)*** | (-5.10)*** | (-5.07)*** |
| lnpatent*lnINTUSERS | | | 0.067 | 0.042 | 0.042 |
| | | | (8.08)*** | (5.61)*** | (5.58)*** |
| lnMCS*lnINTUSERS | | | 0.194 | 0.155 | 0.155 |
| | | | (6.41)*** | (5.73)*** | (5.70)*** |
| lnFBS | 0.283 | 0.192 | 0.185 | 0.122 | 0.122 |
| | (20.98)*** | (10.31)*** | (10.33)*** | (7.49)*** | (7.45)*** |
| lnSIS | 0.065 | 0.056 | 0.015 | -0.007 | -0.007 |
| | (6.89)*** | (5.45)*** | (1.45) | (-0.79) | (-0.79) |
| lnGCF | 0.036 | 0.036 | 0.033 | 0.036 | 0.036 |
| | (8.03)*** | (7.16)*** | (6.79)*** | (8.50)*** | (8.45)*** |
| lnL | 0.033 | 0.814 | 0.434 | 0.093 | 0.093 |
| | (0.27) | (6.37)*** | (3.43)*** | (0.82) | (0.81) |
| lnSET | -0.031 | -0.041 | -0.038 | -0.039 | -0.039 |
| | (-2.04)** | (-2.54)** | (-2.44)** | (-2.87)** | (-2.85)** |
| lnTRADE | 0.066 | 0.238 | 0.219 | 0.117 | 0.117 |
| | (1.69)* | (5.46)*** | (5.24)*** | (3.11)** | (3.09)** |
| Constant | 6.642 | 1.184 | 5.382 | 6.707 | 6.707 |
| | (12.00)*** | (1.87)* | (7.17)*** | (9.95)*** | (9.90)*** |
| Log likelihood | -1346.208 | -1415.835 | -1351.94 | -1197.578 | -1197.578 |
| Wald chi² | 5197.81*** | 4546.34*** | 5141.55*** | 6840.59*** | |
| Autocorrelation | No | No | No | No | |
| Observation | 1323 | 1323 | 1323 | 1323 | 1323 |

**Note:** *** denote 1% significance level, ** denote 5% significance level, * denote 10% significance level. Z-statistics are in parentheses.

### 4.1.7. Granger Causality Test

Figure 3 presents the pictorial evidence of the causal relationship between lnGDPCAP and the independent variables, while table 8 highlights the significant causal relationships among all the variables. Precisely, a one-way and two-way granger causality relationship was established between the dependent and independent variables. To be more specific, it is evidenced that lnGDPCAP, lnTRADE, lnFBS, IQ, lnMCS, lnPATENT, and lnINTUSERS have a bidirectional causal relationship, also a two-way Granger causality. This indicates that a variation in any of the variables explains a variation of the other. On the other hand, one-way causal relationships were established from lnGDPCAP to lnSMP, lnSET, lnGCF, and lnL, signaling that lnGDPCAP causes variations in the aforementioned but not vice versa.
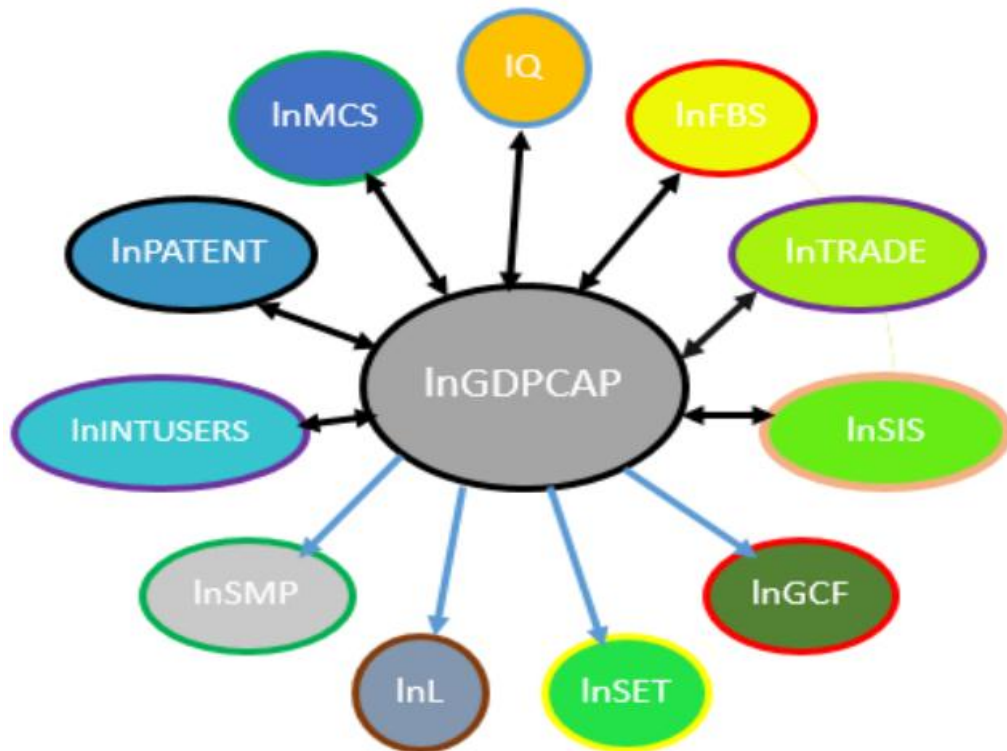


**Figure-3.** Pragmatic display of 12-way causal linkages among the variables. → and ↔ denote unidirectional and bidirectional causal linkages. The Blue arrow depicts a unidirectional causal linkage from the dependent variable (lnGDPCAP) to the independent variables exhibited. The black arrow depicts the bidirectional causal linkage between the dependent and the independent variable.

### 4.2. Discussion

Understanding whether social capital and social innovation endogenously contribute to economic growth is imperative in this technological age. Nonetheless, this present study endeavors to empirically investigate that connection to offer more insight into the subject matter. The study utilized the endogenous growth model proposed by Thompson (2018) for empirical analysis. Furthermore, some econometric techniques were employed to empirically examine the relationship between social capital, social innovation, and economic growth. From the findings, the study observed a positive, consistent, and robust correlation between social capital (institutional quality-trust), social innovation (internet usage) as well as technological adoption (fixed broadband subscription and secured internet servers), proxy variables, and economic growth. The positive correlation found between economic growth, social capital, and social innovation reaffirm Thompson (2018) innovation-based growth model as an endogenous relationship. In an obvious way, previous studies documented that the relationship between economic growth and social capital measured with trust are proportionally related, and perhaps are strongly dependent on each other (Alesina & La Ferrara, 2002; Bjørnskov, 2006; Dinda, 2008; Sobel, 2002; Tau, 2003).

**Table-8.** Granger causality test.

| Pairwise Granger Causality Tests | | | |
|---|---|---|---|
| lnGDPCAP → lnSMP*** | lnSET ↔ lnSMP **/*** | lnFBS ↔ IQ**/* | lnINTUSERS → lnGCF** |
| lnPATENT ↔ lnGDPCAP** | lnSIS ↔ lnSMP *** | lnGCF ↔ IQ**/*** | lnSET → lnL*** |
| LNMCS ↔ lnGDPCAP**/*** | lnSMP ↔ lnTRADE*** | IQ → lnL*** | lnSIS → lnL*** |
| IQ ↔ lnGDPCAP*/** | lnINTUSERS ↔ lnSMP***/* | lnSET -> IQ* | lnTRADE → lnL*** |
| lnFBS ↔ lnGDPCAP *** | lnPATENT → IQ** | IQ → lnSET*** | lnINTUS → lnL*** |
| lnGDPCAP → lnGCF*** | lnFBS ↔ lnPATENT** | IQ → lnSIS*** | lnSIS ↔ lnSET***/** |
| lnGDPCAP → lnL*** | lnGCF ↔ lnPATENT** | IQ → lnTRADE** | lnINTUSERS ↔ lnSET***/** |
| lnGDPCAP → lnSET*** | lnPATENT ↔ lnL** | IQ → lnINTUSERS** | lnTRADE ↔ lnSIS**/*** |
| lnSIS ↔ lnGDPCAP*** | lnPATENT → lnSET** | lnFBS → lnGCF* | lnINTUSERS → lnSIS*** |
| lnTRADE ↔ lnGDPCAP** | lnPATENT ↔ lnSIS**/* | lnFBS → lnL*** | lnTRADE → lnINTUSERS** |
| lnINTUSERS ↔ lnGDPCAP**/* | lnINTUSERS → lnPATENT* | lnFBS → lnSET*** | |
| lnPATENT ↔ lnSMP***/** | lnMCS → lnFBS** | lnSIS → lnFBS** | |
| lnSMP ↔ lnPATENT**/*** | lnMCS → lnL** | lnINTUSERS → lnFBS***/** | |
| lnMCS ↔ lnSMP***/** | lnMCS → lnSET** | lnGCF → lnL*** | |
| IQ ↔ lnSMP ***/** | lnMCS → lnSIS** | lnGCF → lnSET** | |
| lnFBS ↔ lnSMP***/** | lnTRADE → lnMCS** | lnSIS → lnGCF** | |
| lnL ↔ lnSMP** | lnINTUSERS ↔ lnMCS**/*** | lnTRADE → lnGCF*** | |

**Note:** *** denote 1% significance level, ** denote 5% significance level, * denote 10% significance level. ↔ denote bidirectional causality, → denote unidirectional causality.

The findings of the study suggest that social innovation positively and significantly impact economic growth. This contention with Urama and Acheampong (2013) asserts that social innovation spurs growth through job security and competition among businesses that induce the production of goods and services. Moreover, social innovation serves as the problem solver for the world's most pressing issues, such as mobile money transfer, distance education, zero-carbon housing, restorative justice, and fair trade (Vitenu-Sackey, Oppong, & Bathuure, 2021). Innovation in the banking sectors extensively promotes financial inclusion, directly and indirectly impacting growth by ensuring vulnerable persons' economic inclusion (Guoping & Vitenu-Sackey, 2021; Hongli & Vitenu-Sackey, 2019; Vitenu-Sackey, 2020). On the other hand, social innovation changes basic practices, beliefs, social power structures, and resources profoundly. On this tenet, social innovation enhances social capital, thus social networking and social trust. The study's findings suggest that internet-related innovations propel economic growth but not any ordinary innovation. Furthermore, it observed that when social innovation and social capital coexist as they are endogenous to economic growth, patent and mobile cellular subscription negatively impact economic growth. However, when patent and mobile cellular subscriptions interact with internet usage, they play a positive role in economic growth. According to Bailey, Cao, Kuchler, Stroebel, and Wong (2018), the rise in social media has maintained and created new and enormous opportunities through social connectedness, enabling the transfer of knowledge to be positive and significant on economic growth. This stride has been chalked from the emergence of the Internet. Furthermore, Bailey et al. (2018) suggested that the rise in social networking with support from the Internet has paved the way for innovators to build on other innovators' ideas through social connectedness or networking to increase efficiency spur productivity.

## 5. CONCLUSION AND POLICY IMPLICATION

The study assessed the role of social capital and social innovation in economic growth. Nonetheless, a panel of 147 countries was sampled from 2009 to 2017, and panel econometric techniques were utilized to arrive at a statistical conclusion. The techniques used in the estimation are contemporaneous correlation estimators; thus, panel corrected standard errors, panel generalized least square with correlation disturbances, and generalized linear model. Upon estimations, the study concluded that social capital and social innovation strongly play a positive role in economic growth. Therefore, in pursuit of sustainable economic growth, social capital accumulation; thus, social trust and social networking are essential. Moreover, social innovations that are internet-related positively contribute to economic growth sustainably. As has been established in this present study that social capital and social innovation play a positive role in economic growth. Some policy recommendations are proposed for sustainable economic growth:

(1) The study recommends that investment in digital communication technologies should be prioritized because it improves material living standards because it lowers the cost of maintaining and creating professional and personal ties, strengthening the diffusion of knowledge and ideas, and further creating productivity spillovers positively.

(2) Regarding the two-way causal linkage between patent registration, internet usage, mobile cellular subscription, secured internet servers, fixed broadband subscription, the openness of an economy, and institutional quality (social trust); the study recommends that policymakers and governments should craft policies that could inure to the advantage of internet usage, patent registration, mobile cellular subscription, secured internet servers, and fixed broadband subscription. More importantly, institutional quality must be adhered to because of its effectiveness in cultivating social trust and strengthening social networking. Specifically, strengthening the rule of law, ensuring voice and accountability, enhance public and private sector regulatory quality, maintain political stability, ensuring governments' effectiveness, and controlling corruption. On the other hand, the openness of the economy should be ensured to transfer knowledge and information.

(3) The significant driver of social capital and social innovation is technological advancement. Therefore, investment in up-to-date technologies and human capital must be ensured to support modern social networking, information, and knowledge transfers to speed up competition and bring out the innovative and creative prowess of indigenes.

(4) Lastly, the unidirectional causal linkage established from economic growth to gross capital formation, school enrolment (education–investment in human capital), labor participation, and social network; hence, policymakers should enact policies that offer triple triumph; thus, a triumph for government, society, and individuals characterized by affordability, beneficial, and add value to the standard of living of citizens.

**Abbreviations:**

*LLC*=Levin, Lin & Chu test, *IPS*= Im, Pesaran & Shin test, *ADF Fisher and PP Fis*her = Maddala et al. Chi-square tests, *Pesaran CD*= Pesaran cross-sectional dependence test, *Sig.* = Significance level, *ln* =Natural logarithm, *lnGDPCAP* = Gross domestic product per capita, *lnSMP* = Social media penetration rate, *lnPATENT*= patent registrations, *lnMCS* = mobile cellular subscribers, *IQ* = institutional quality, *lnFBS* = fixed broadband subscribers, *lnL*=Labour participation rate, *lnSET* = School enrolment rate at tertiary level, *lnSIS* = Secured internet servers, *lnTRADE* = trade openness, *lnINTUSERS* = Internet users, *lnINTUSERS\*lnPATENT* = Interaction between internet users and patent registration, *lnINTUSERS\*lnMCS* = Interaction between internet users and mobile cellular subscription, *M* =Mean, *SD* = Standard deviation, *GLM* = Generalised linear model, *GLS* = Generalised least square.

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## APPENDIXS

Table-9. Variables measurement and description.

| Variable | Measurement | Description | Source |
|---|---|---|---|
| lnSMP | Social capital: Social network | Social (network) media penetration: Average of four platforms with the highest penetration; thus Facebook, YouTube, Twitter, and Pinterest | gs.statcounter.com |
| lnFBS | Technology | Fixed broadband subscriptions (per 100 people) | World Development Indicators, World Bank |
| lnGDPCAP | Economic growth | GDP per capita (constant 2010 US$) | World Development Indicators, World Bank |
| lnGCF | Capital stock - Physical capital accumulation | Gross capital formation (constant 2010 US$) | World Development Indicators, World Bank |
| lnMCS | Social innovation | Mobile cellular subscriptions (per 100 people) | World Development Indicators, World Bank |
| lnSIS | Technology | Secure Internet servers (per 1 million people) | World Development Indicators, World Bank |
| lnINTUSERS | Social innovation | Individuals using the Internet (% of population) | World Development Indicators, World Bank |
| lnL | Labour participation | Labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate) | World Development Indicators, World Bank |
| lnSET | human capital accumulation | School enrollment, tertiary (% gross): This is the ratio of total enrolment, that officially corresponds to the secondary level of education regardless of age, to the population of the age group | World Development Indicators, World Bank |
| lnTRADE | Openness of economy | Trade (% of GDP) | World Development Indicators, World Bank |
| lnPatent | Social innovation | Total number of patent registrations | World Development Indicators, World Bank |
| IQ | Social capital: social trust | Average score of the six indicators for institutional governance; thus rule of law, corruption control, voice and accountability, political stability, regulatory quality and government effectiveness | Worldwide Governance indicators, World Bank |

**Table-10.** List of countries sampled for the study.

| Countries sampled for the study | | | | |
|---|---|---|---|---|
| Albania | The Republic of Congo | Kazakhstan | Palestinian Territory | Uruguay |
| Algeria | DR Congo | Kenya | Panama | Uzbekistan |
| Angola | Costa Rica | Republic of Korea | Paraguay | Venezuela |
| Argentina | Cote D'ivoire | Kyrgyzstan | Peru | Viet Nam |
| Armenia | Croatia | Lao | Philippines | Zambia |
| Australia | Cuba | Latvia | Poland | Zimbabwe |
| Austria | Cyprus | Lebanon | Portugal | United States |
| Azerbaijan | Czech Republic | Lesotho | Puerto Rico | |
| Bahamas | Denmark | Lithuania | Qatar | |
| Bahrain | Dominican Republic | Luxembourg | Romania | |
| Bangladesh | Ecuador | Macao | Russian Federation | |
| Barbados | Egypt | Macedonia, North | Rwanda | |
| Belarus | El Salvador | Madagascar | Saudi Arabia | |
| Belgium | Estonia | Malawi | Senegal | |
| Belize | Finland | Malaysia | Serbia | |
| Benin | France | Mali | Singapore | |
| Bhutan | Georgia | Malta | Slovakia | |
| Bolivia | Germany | Mauritania | Slovenia | |
| Bosnia And Herzegovina | Ghana | Mauritius | South Africa | |
| Botswana | Greece | Mexico | Spain | |
| Brazil | Guatemala | Republic of Moldova | Sri Lanka | |
| Brunei Darussalam | Guinea | Mongolia | Sudan | |
| Bulgaria | Honduras | Montenegro | Swaziland | |
| Burkina Faso | Hong Kong | Morocco | Sweden | |
| Burundi | Hungary | Mozambique | Switzerland | |
| Cambodia | Iceland | Namibia | Tajikistan | |
| Cameroon | India | Nepal | Tanzania | |
| Canada | Indonesia | Netherlands | Thailand | |
| Cape Verde | Islamic Republic of Iran | New Zealand | Togo | |
| Central African Republic | Ireland | Nicaragua | Tunisia | |
| Chad | Israel | Niger | Turkey | |
| Chile | Italy | Nigeria | Uganda | |
| China | Jamaica | Norway | Ukraine | |
| Colombia | Japan | Oman | United Arab Emirates | |
| Comoros | Jordan | Pakistan | United Kingdom | |