The effect of the Internet on economic growth in Southern African countries: A combination of panel and time series approaches

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Abstract

This study examines the relationship among Internet usage, economic growth, financial development and trade openness using panel data for a panel of Southern African countries for the period 1990-2012. It estimates an encompassing model of short and long-run effects using the Pooled Mean Group regression technique. The findings indicate positive long run relationship between Internet usage and economic growth at 1% level of significance. The relationship in the short-run is insignificant. Both financial development and trade openness stimulate economic growth in the region. However, the short-run association between economic growth and these variables are insignificant. Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) methods are applied for individual countries. Results from these estimates support the panel results for most of the countries. Based on findings, the study recommends that the policy makers of these countries must recognize the importance of the Internet in their economies and subsequently promote investment in building and expanding Internet infrastructure taking into cognizance the digital divide issue both within countries and across the panel.

Keywords: DOLS, Economic growth, FMOLS, Internet usage, Southern African panel, Pooled mean group regression.
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1. Introduction

The penetration of the Internet usage as a part of the Information and Communication Technology (ICT) revolution is believed to be a significant contributor towards social and economic development. Quite expectedly, there has been spectacular growth in Internet usage especially in the past two decades in most of the developed and developing countries. Such phenomenal growth in Internet usage is attributed to the increasing investment in the rolling out of fixed and wireless Internet infrastructures expanding the bandwidth available for all types of communication services. All these services of the Internet are believed to have been transforming economies with regards to productivity, growth and other macroeconomic effects (Zhang, 2013).

Although several studies have been undertaken to investigate the effects of ICT on macroeconomic variables such as economic growth, productivity, international trade, inflation, financial development, stock market development and unemployment, the direct impact of Internet usage on growth and other macroeconomic variables is still an under-investigated field of research (Elgin, 2013).

Studies investigating the direct effects of the Internet on economic growth in Southern African countries are almost absent although Internet infrastructure has expanded in these countries in the last decade. This study is an attempt to fill this void.

The remainder of the paper is structured as follows; Section 2 presents a literature review and Section 3 outlines the data and methodological framework of this research. Section 4 presents the estimation results and Section 5 offers conclusions and policy implications.

2. Literature Review

2.1 Internet and the economy: Theoretical perspective

Internet usage enables dissemination of information and ideas in markets. Modern theories of endogenous growth (e.g., Lucas 1988; Romer 1986, 1990; Aghion and Howitt 1998; Barro, 1998) state that the Internet should boost economic growth by facilitating the development and adoption of innovation processes. Internet usage may accelerate the diseemination of ideas and information and intensify competition through development and diversification of new products, processes, and business models which eventually propell macroeconomic growth.

Romer's (1986, 1990) endogenous growth model argued that endogenous growth theories model the generation and distribution of ideas and information as the catalysts of economic growth

(Lucas, 1988; Romer, 1990; Aghion and Howitt, 1998). As such, the massive growth in Internet usage may enhance the innovative capacities of the economy through knowledge spillover, development of new products and processes, and business models to promote growth. Moreover, cheaper information dissemination encourages the adoption of new technologies which help stimulate economic growth (Nelson and Phelps, 1966; Benhabib and Spiegel, 2005). This also suggests that information technology can affect economic growth through other channels such as codified knowledge across firms and regions. The Internet further enables the exchange of data across multiple locations and facilitates the decentralization of information processing. It also potentially contributes towards the emergence of new business and firm-cooperation models that rely on the spatial exchange of large batches of information resulting in intensified competition and innovation processes. The Internet may increase market transparency and thus additionally intensify competition. Extensive use of the Internet fundamentally changed and improved the processing of information, resulting in significant productivity growth of IT-using firms (Stiroh, 2002; Jorgensen et al., 2008).

2.2 Internet and the economy: Empirical evidence

Empirical evidence suggests that the Internet potentially increases total output and affects economic growth positively (Zhang, 2013; Koutroumpis, 2009; Choi and Yi, 2009; Holt and Jamison, 2009; Cette et al., 2005; Kim and Oh, 2004; Klein, 2003). The Internet stimulates foreign direct investment (Choi, 2003). It also contributes towards lowering the inflation rate by reducing transaction cost and improving efficiency in the economy (Meijers, 2006; Yi and Choi, 2005). It enhances bilateral and international trade by reducing communication and transportation costs (Choi, 2010; Freund and Weinhold, 2004) and potentially reduces unemployment (Najarzadeh et al., 2014). The Internet also promotes exchange traded funds (ETF) and thus boosts investment in the economy (Lechman and Marszk, 2015).

At a micro level, the Internet has been able to enhance labor productivity and has led to major revenue increases and cost savings in developed countries (Litan and Rilvin, 2001; Varian et al., 2002). By reducing information asymmetry in the market, identifying customers and production standards, the Internet also helps boost exports at the firm level (Clarke,2008).

Empirical literature separately investigating the direct effects of the Internet on economic growth and other macro variables started evolving during the past decade and most of these studies have used panel data. Frehund and Weinhold (2002) investigated the effect of the Internet on service trade and found a positive significant relationship between them.

Choi (2003) studied the effect of the Internet on inward foreign direct investment (FDI) using data for a panel of 14 source countries and 53 host countries. The study applied cross-country regression on a gravity FDI equation and findings indicated that a 10% increase in the number of Internet users in a host country raised FDI inflows by 2%. Frehund and Weinhold in another study (2004) that ran both time series and cross-section regressions on a sample of 53 countries, found that the Internet stimulated trade. The study further observed that the Internet reduced market-specific fixed costs which contribute towards export growth.

Yi and Choi (2005) employed pooled OLS and random effects models for a panel of 207 countries. Their results showed that a 1% increase in the number of the Internet users led to a 0.42% drop in inflation. Noh and Yoo (2008) tested the empirical relationship among Internet adoption, income inequality and economic growth using a panel of 60 countries for the period 1995-2002. They found that the Internet's effect on economic growth is negative for countries with high income inequality. The findings were attributed to the presence of a digital divide in these countries.

Choi and Yee (2009) used data for a panel of 207 countries for the period 1991-2000 to examine the impact of the Internet on economic growth while controlling for some macro variables. They used a number of panel econometric techniques to control for endogeneity among the explanatory variables. Their findings supported the significant positive role of the Internet in spurring economic growth.

Holt and Jamison (2009) analysed the association between ICT and economic growth as well as the connection between broadband Internet and economic growth. The study supported the positive impact of broadband deployment and adoption on economic growth in the USA. Choi (2010) estimated the effect of the Internet on service trade and found a significant positive relationship between the number of the Internet users and total service trade. It was concluded that a 10% increase in the number of Internet users prompted an increase in service trade of between 0.23% and 0.42%.

Lio et al. (2011) estimated the effects of the Internet adoption on reducing corruption in a panel of 70 countries for the period 1998-2005. Using the Granger causality test to find the causal link, they further applied dynamic panel data models (DPD) to estimate the relationship between variables while addressing the endogeneity problem. The empirical results indicated significant role of the Internet in reducing corruption. Goel et al. (2012) obtained similar results in their cross-sectional empirical analysis.

Zhang (2013) developed the Internet consumption model and conducted a cross-country empirical research examining the relationship between income, the Gini index and the pattern of the internet diffusion curve. His findings indicated that the developed countries had steeper Internet diffusion curves and shorter time lags than developing countries. The Gross Domestic Product (GDP) per capita had positive correlation with the slope of the Internet diffusion curve while the Gini index had negative correlation.

Elgin (2013) used a panel data of 152 countries for the period 1999-2007 to investigate the effects of the Internet on the size of the shadow economy. The study used cross-country regressions and found that the association between the Internet usage and the shadow economy strongly interacts with GDP per capita. The study further highlighted two opposing effects of Internet usage-the increasing productivity effect reducing the size of the shadow economy and the increasing tax evasion effect increasing the size of the shadow economy. Mack and Rey (2014) showed that in 49 out of 54 metropolitan areas in the USA, the Internet enhanced productivity in knowledge intensive firms. Maria et al. (2013) demonstrated that deployment of mobile communication and greater use of Internet technologies were associated with a higher level of technical efficiency in high and low-income countries.

Choi et al. (2014) investigated the determinants of international financial transactions using cross country panel data on bilateral portfolio flow between the USA and 38 other countries for the period 1990-2008. The study estimated the effect of the Internet on the cross-border portfolio flows into the USA from other countries in the panel. It employed the gravity model and found that the Internet reduces information asymmetry and thus increases cross-border portfolio flows. The results were robust across different empirical models.

Najarzadeh et al. (2014) investigated the effect of the Internet on labor productivity using data for a panel of 108 countries for the period 1995-2010. Employing the pooled OLS, fixed effect, and one-step and two-step GMM methods to estimate the relationship. The empirical exercise suggested a positive and strong significant relationship between Internet use and labor productivity. Gruber et al. (2014) estimated the returns from broadband infrastructure for the period 2005-2011 and also assessed the cost of broadband roll out under different assumptions of technical performance. Their findings contrasted with the forecasted benefits from the expansion of broadband coverage. However, the study also found that the future benefits to be reaped from a broadband roll out project outweigh the investment involved therein for the highest performance technologies. The study recommended public subsidies to promote building high-speed broadband infrastructure.

Czernich (2014) examined the relationship between broadband Internet and unemployment rate using data of various municipalities of Germany. Simple OLS regression indicated a negative relationship between broadband Internet and unemployment while such an association between these variables could not be confirmed with the introduction of an instrument variable in the same study. Lechman and Marszk (2015) examined the relationship between ICT penetration and exchange traded funds (ETF) for Japan, Mexico, South Korea and the United States over the period 2002-2012 using two core indicators of ICT, 'number of Internet users per 100 people' and 'Fixed Broadband Internet subscriptions per 100 people'. Using logistic growth models to analyse the data, the study found a positive, strong and significant relationship between ICT penetration and ETF.

3. Data and Methodological framework

3.1 Data

This study used a dynamic panel dataset for 11 Southern African countries for the period 1991-2012[1]. The core variables used in the study were real GDP per capita growth rate measured at a constant US$2000 price and the number of Internet users per 100 people, i.e., individuals who have worldwide access to and used the Internet from any location in the last three months from the time of data collection.

As bivariate models are likely to suffer from variable omission bias (Lean and Smyth, 2010), this study includes two potential growth drivers - financial development (FD) measured by private sector credit as a share of GDP and trade openness (TO) measured by the total exports and imports as a share of GDP. Data for all these variables were obtained from the World Data Bank, 2013 (previously, World Development Indicators (WDI) database).

3.2 Methodology

3.2.1. The model

[1] Angola, Botswana, Lesotho, Madagaskar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe,

Based on the endogenous growth models (e.g., Lucas 1988; Romer 1986, 1990; Aghion and Howitt 1998; Barro, 1998) and following the growth equation used in Choi and Yi (2009), we construct an econometric model with per capita GDP growth rate as a function of the number of Internet users per 100 people, financial development (FD), trade openness (TO) and government expenditure (GOV). Therefore, the growth equation used in the study was:

$$Growth_{it}=\beta_0+\beta_1 NET_{it} + \beta_2 FD_{it}+\beta_3 TO_{it} +\varepsilon_{it} \qquad (1)$$

where $\varepsilon_{it} = \mu_i+ \nu_{it}$ while $\mu_i \approx (0, \sigma^2 \mu)$ and $\nu_{it} \approx (0, \sigma^2 \nu)$ are independent of each other and among themselves. μ_i and ν_{it} denote country-specific fixed effects and time variant effects respectively. The subscripts *i, t* represent country (i= 1....31) and time period (1991-2012) respectively.

3.2.2 Estimation procedures

The study performs the following estimations:

i. A number of unit root tests are conducted to verify the stationarity of data.

ii. This follows Pedroni cointegration test to verify the presence of long-run relationship among the variables.

iii. PMG estimation is then performed to estimate short - and the long-run relationship and the speed of error correction.

iv. In order to check the robustness of the long run relationship in the panel for individual countries, DOLS and FMOLS methods are applied.

v. Next, panel VECM Granger causality test is performed to assess the causal link among the variables.

vi. Finally, impulse response function and variance decomposition analysis are performed to forecast the relationship for a 22-year time horizon.

3.2.3. Tests for Unit Roots

To avoid the risk of non-stationarity in a long dataset like ours, it was necessary to check the presence of unit root in the data. In order to do this, a number of panel unit root tests are conducted.

3.2.4. Panel Cointegration Test

Since results from the unit root tests confirm that the data are stationary at first difference [I(1)], indicating a long-run cointegrating relationship between the variables, we conducted several panel cointegration tests suggested by Pedroni (1997, 1999 and 2000) to examine whether such a relationship between the variables really exists. Pedroni test is appropriate in the present circumstance as it allows multiple regressors. Pedroni (1997) provides seven panel cointegration statistics for seven tests. Four of those are based on the within-dimension tests while the other three are based on the between-dimension or group statistics approach.

The starting point of the residual-based panel cointegration test statistics of Pedroni (1999) is the computation of the residuals of the hypothesized cointegrating regression as follows:

$$y_{i,t} = \alpha_i + \beta_{1i,}x_{1i,t} + \beta_{2i}x_{2i,t} + \cdots + \beta_{Mi}x_{Mi,t} + \varepsilon_{i,t} \qquad (5)$$

$$t = 1, \dots \dots, T; i = 1, \dots., N; m = 1, \dots \dots, M$$

where T is the number of observations over time, N denotes the number of individual members in the panel, and M is the number of independent variables. It was assumed here that the slope coefficients $\beta_{1i}, \dots \beta_{Mi}$, and the member-specific intercept α_i can vary across each cross-section. To compute the relevant panel cointegration test statistics, the panel cointegration regression in equation (1) should be estimated first. For the computation of the panel ρ and panel-*t* statistics, we took the first difference of the original series and estimate the residuals of the following regression:

$$y_{i,t} = b_{1i,}\Delta x_{1i,t} + b_{2i}\Delta x_{2i,t} + \cdots + b_{Mi}\Delta x_{Mi,t} + \pi_{i,t} \qquad (6)$$

Using the residuals from the differenced regression, with a Newey-West (1987) estimator, we calculated the long run variance of $\hat{\pi}_{i,t}^2$ which is symbolized as $\hat{L}_{11i}^2$

$$\hat{L}_{11i}^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{\pi}_{i,t}^2 + \frac{2}{T}\sum_{s=1}^{k_i}(1 - \frac{s}{k_i+1})\sum_{t=s+1}^{T}\hat{\pi}_{i,t}\hat{\pi}_{i,t-s} \quad (7)$$

For panel ρ and group ρ statistics, we estimated the regression using the $\hat{e}_{i,t} = \hat{\gamma}_i\hat{e}_{i,t-1} + \hat{u}_{i,t}$ using the residuals $\hat{e}_{i,t}$ from the cointegration regression (2). Then compute the long-run variance ($\hat{\sigma}_i^2$) and the contemporaneous variance ($\hat{s}_i^2$) of $\hat{u}_{it}$ where, $\hat{s}_i^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{u}_{i,t}$

$$\hat{\sigma}_i^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{u}_{it} + \frac{2}{T}\sum_{s=1}^{k_i}(1 - \frac{s}{k_i+1})\sum_{t=s+1}^{T}\hat{u}_{i,t}\hat{u}_{i,t-s} \qquad (8)$$

where k_i is the lag length. In addition to this, we also calculated the term, where, $\lambda_i = \frac{1}{2}(\hat{\sigma}_i^2 - \hat{s}_i^2)$ On the other side for panel-*t* and group-*t* statistics using again the residuals of $\hat{e}_{i,t}$ of cointegration regression (1), we estimate $\hat{e}_{i,t} = \hat{\gamma}_i\hat{e}_{i,t-1} + \sum_{t=1}^{k}\hat{\gamma}_{ik}\Delta\hat{e}_{i,t-1} + \hat{u}*_{i,t}$

In this study to determine the lag truncation order of the ADF *t*-statistics, the step-down procedure and the Schwarz lag order selection criterion were used where

$$\hat{s}_i^{*2} = \frac{1}{T}\sum_{t=1}^{T} \hat{u}_{i,t}^{*2} \quad , \quad \tilde{s}_{i,t}^{*2} \equiv \frac{1}{N}\sum_{i=1}^{N} \hat{s}_i^{*2}$$

The next step is the calculation of the relevant panel cointegration statistics using the following expressions.

Panel $-\rho$ statistic

$$T\sqrt{N}Z_{\hat{\rho}N,T-1} \equiv T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{i}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i \quad (9)$$

Panel $-t$ statistic

$$Z_{tN,T}^{*} \equiv \left(\tilde{s}_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{i}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} \quad (10)$$

Group $-\rho$ statistic

$$TN^{-1/2}\tilde{Z}_{\hat{\rho}N,T-1} \equiv TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i) \quad (11)$$

Group $-t$ statistic

$$N^{-1/2}\hat{Z}_{tN,T}^{*} \equiv TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_i^{*2}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} \quad (12)$$

Lastly, we apply the appropriate mean and variance adjustment terms to each panel cointegration test statistic so that the test statistics were standard normally distributed.

$$\frac{\chi_{N,T} - \mu\sqrt{N}}{\sqrt{v}} => N(0,1)$$

where $\chi_{N,T}$ is the appropriately standardized form of the test statistic, and are the functions of moments of the underlying Brownian motion functionals. Different panel cointegration test statistics are provided in Table 2 in Pedroni (1999).

The null hypothesis of no cointegration for the panel cointegration test was the same for each statistic, $H_0 : \gamma_i = 1$ for all i whereas the alternative hypothesis for the between-dimension-based and within-dimension-based panel cointegration tests differed. The alternative hypothesis for the between-dimension-based statistics was $H_1 : \gamma_i < 1$ for all i; where a common value for $\gamma_i = \gamma$ was not required. For within-dimension-based statistics, the alternative hypothesis was $H1 : \gamma = \gamma_i < 1$ for all i and it assumed a common value for $\gamma_i = \gamma$. Under the alternative hypothesis, all the panel cointegration test statistics considered in this paper diverged to negative infinity. Thus, the left tail of the standard normal distribution was used to reject the null hypothesis.

3.2.5 Pooled Mean Group Regression (PMG)

One major shortcoming of Pedroni tests is that they do not estimate for the short-run relationship and the adjustment term of the short-run disequilibrium towards the long run equilibrium relationship (Murthy, 2007). Therefore, we applied the PMG technique allows short-term adjustments and convergence speeds to vary across countries, thus allowing cross-country heterogeneity. It imposes cross-country homogeneity restrictions only on the long-run coefficients. The justification for common long-run coefficients across OECD countries was that they have access to common technologies and have intensive intra-trade and foreign direct investment.

As the short-run adjustment depends on country-specific characteristics such as vulnerability to domestic and external shocks (for example, recent debt crisis in Greece and financial mismanagement, different types of adjustment to the recent global financial crisis), monetary and fiscal adjustment mechanisms. financial-market imperfections, lack of sufficient time for implementation of different Internet and digital divide policies and change in political regime etc., allowing the speed of covergence to vary is justified.

Pesaran and Smith (1995), Pesaran (1997) and Pesaran et al. (1999) showed that PMG can render consistent and efficient estimates even in case of mixed order of integration. In order to comply with the requirements for standard estimation and inference, the long-run growth regression equation (equation 1) was embedded into an ARDL (*p, q*) model. In error correction form, this can be written as follows:

$$\Delta(y_i)_t = \sum_{j=1}^{p-1} \gamma^i_j \Delta(y_i)_{t-j} + \sum_{j=0}^{q-1} \delta^i_j \Delta(x_i)_{t-j} + \varphi^i \left[(y_i)_{t-1} - \beta^i_1 (X_i)_{t-1}\}\right] + \varepsilon_{it} \qquad (13)$$

where γ^i_j and δ^i_j are short run coefficients, φ^i is the error correction adjustment speed, β^i_1 are the long- run coefficients and $\varepsilon_{it} = \mu_i + \nu_{it}$ where μ_i and ν_{it} denote country-specific fixed effects and time variant effects respectively.

3.2.6 Panel VECM Granger Causality

If and once the variables are found to be first difference stationary [I(1)], assessing the causal direction of the relationship between them is important (Granger, 1969). Information about the exact direction of the causal link enables a more pragmatic and relevant discussion of the policy implications of the findings (Shahbaz et al., 2012).

3.2.7 Variance decomposition analysis

Despite its importance for policy implications, one of the weaknesses of the causality analysis is that it can not predict the strength of the causal relationship beyond the sample period. To overcome this limitation and to forecast the Internet-growth relationship beyond the sample period, this study employs variance decomposition analysis. The variance decomposition (Pesaran and Shin, 1998) measures the percentage contribution of each innovation to h-step ahead of the forecast error variance of the dependent variable and provides a means to determine the relative importance of shocks in independent variables to explain the variation in the dependent variable beyond the selected time period. Engle and Granger (1987) and Ibrahim (2005) argued that the variance decomposition approach produces more reliable results as compared to those from other traditional approaches.

4. Empirical Results

Table 1 presents descriptive statistics of all the variables. It reveals that the data were fairly dispersed around the mean.

<Insert table 1 here>

Table 2 presents the Variance Inflation Factor (VIF) results which clearly demonstrates that all VIF values were less than 5 implying no multicollinearity issue in the study.

<Insert table 2 here>

The unit root results are reported in Table 3. The results show that all the series were first-difference stationary indicating the presence of unit root. This implies a cointegrating relationship among the variables.

<Insert table 4 here>

Table 4 presents results from the Pedroni cointegration test. All Pedroni test statistics except the v statistic have a critical value of -1.64.The v statistic has a critical value of 1.64. It is evident from Table 5 that the statistical values of five out of seven tests were greater than the critical values which indicates the rejection of the null hypothesis of no cointegration. Nevertheless, among the seven test statistics, the group rho statistic has the best power (Gutierrez, 2003) which was also greater than the critical value. Thus, it can be concluded that there is a long run cointegrating relationship among the variables.

<Insert table 4 here>

Table 5 presents results from the PMG estimations. The findings indicate that there is a positive significant relationship between Internet usage and economic growth in Southern African countries in the long-run. The long-run relationship between economic growth and financial development and trade openness were also found positive and significant. However, the short-run relationship between the variables were insignificant.

<Insert table 5 here>

The error correction coefficient of ECT_{t-1} was −0.750 which was statistically significant at the 1% level of significance. From these results, it can be concluded that changes in economic growth are corrected by 75% in each year in the long-run. It further suggests that a full convergence process will take only 1.25 years to reach the stable path of equilibrium.

Table 6 reports Granger causality results. It shows that the Internet usage Granger causes economic growth in the OECD countries. Economic growth has no causal link with financial development, government expenditure and trade openness. A unidirectional causal link running from Internet usage to financial development and government expenditure was also observed.

<Insert table 6 here>

Variance decomposition analysis results are presented in Table 7. The results forecast that the Internet usage will have an increasing effect on economic growth in the region in future also during the period 2013-2034. In the first 5-year time horizon (up to 2017), 0.20% of the variation in the growth rate is expected to be explained by Internet usage followed by 1.15% in the 10th year (2022). In the third 5-year time horizon (up to 2027), Internet usage is forecasted to explain 2.12% of the variation in per capita GDP growth rate. In the fourth time horizon (up to 2032), the forecasted variance in the growth rate to be explained by Internet usage stands at 2.96% which is expected to rise further to 3.27% in the 22nd year (2034). Other variables are also forecasted to continue to affect growth rate during the period. In the 22nd year, 10.34%, 2.59% and 0.147% of the variations in growth rate are explained by financial development, trade openness and government expenditure, respectively.

<Insert table 7 here>

5. Conclusions and Policy Implications

This study revisits the relationship between Internet usage and economic growth for 11 Southern African countries. The PMG technique that accounts for endogeneity and heterogeneity issues is applied to estimate the short-run and long-run association between the variables. Application of such a technique is relatively new in the area of the Internet-growth relationship which potentially removes the threat of producing biased and misleading results.

Also, a forecasting analysis of this relationship was performed with the application of variance decomposition method to assess how the Internet is going to impact economic growth in the region in the future. This study also utilizes one of the longest panel datasets. A number of unit root tests were conducted which reported that all the series were stationary at first difference [I(1)]. This was followed by the Pedroni (1999) cointegration test which confirmed a cointegrating relationship among the variables. The PMG technique was then applied to estimate the short- and the long-run relationship among the variables. To assess the causal link between the variables, the Granger causality test was conducted. Finally, variance decomposition analysis was performed to forecast the future potential impact of the Internet on economic growth.

Findings from PMG estimates indicated that there is a positive significant relationship between Internet usage and economic growth in Southern African countries in the long-run. The long-run relationship of economic growth with financial development and trade openness is also positive and significant. However, the short-run relationship between these variables is insignificant.

Also Internet usage was found to Granger cause economic growth. Economic growth has no causal link with financial development and trade openness. A unidirectional causal link running from Internet usage to financial development was also observed. Results from the variance decomposition analysis forecast that Internet usage will have an increasing effect on economic growth in the region in the future also during the period 2013-2034. Other variables, financial development and trade openness will also continue to affect economic growth in the region.

The findings of this study have very important policy implications. First, they imply that Internet usage not only affects economic growth during the sample period of the study (1990-2012) but would also continue to stimulate it in the future. Therefore, it is important that these countries pursue and implement various ICT policies (such as, National Broadband Plan in the USA and National Broadband Network in Australia) with emphasis on developing wireless infrastructure for greater network coverage. But this is not enough. Although, the findings of this empirical exercise may be encouraging for the policymakers of these countries, policymakers can not afford to be complacent for some valid reasons. First, Internet technology is a General Purpose Technology (GPT) (Ceccobelli et al., 2012), so expanding network coverage may be enough in the short-run but not in the long-run. It is argued that without substantial investment in complementary assets, the expected positive effects of the Internet on economic growth may not be accomplished in the long-run (Shahiduzzaman and Alam, 2014; Ceccobelli et al., 2012). Second, with the rapid growth in Internet usage, digital divide in different forms- such as equity divide (inequity in the use), skill divide (some people may not have enough skills to use the Internet effectively while others have), group divide (so called "cyber balkanization" which refers to the creation of new groups or cohorts through Internet contacts who segregate themselves from other groups), speed divide (disparity in speed of Internet connection) and rural-urban divide may potentially hamper its growth effects. An effective policy goal should combine both the elements of demand and supply-side stimulus. Also it should not be forgotten that different policies will have different levels of effectiveness in different countries with diverse initial conditions.

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