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Access to information and communication: estimating the determinants of Internet usage in South Africa

ABSTRACT

This paper attempts to estimate the determinants of Internet usage in South Africa in a theoretically plausible model. The three-step Engle Yoo estimation technique is applied. The results indicate that the number of Internet users is dependent on access to personal computers as well as real wages and salaries. An error correction model is estimated and shocks are applied to the long run variables. The shocks indicate that an increase in wages and salaries is necessary, but not sufficient, for an increase in Internet access. The South African government has implemented numerous policies to address the disparities that exist in the country concerning access to information and communication. Policies such as personal income tax relief and skills development play an integral part in addressing limited access to the Internet, although these policies sometimes contradict the perceived objective.

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INTRODUCTION

To ensure the effective working of a market-based economy, all economic participants need to have access to data and use this information to improve the quality of decisions taken (Zappacosta, 2001). This would imply that a market-based economy is not only driven by economic fundamentals, but also communication and information. Ultimately, this will lead to an information-based economy. Information Communication Technology (ICT) and its complementary networks perform information creation, processing, transport, storage and display functions. These functions are connected to broadcasting and the telecommunication infrastructure. Broadcasting brings news and programmes in the form of sound, video and text to communities, and telecommunications provides the means for transporting and distributing information between communities. To create an information-based economy, the information technology and the broadcasting and telecommunications components need to form a single integrated network (Mangochi, 2000).

Improving the access of economic participants to, and the use of, relevant information will contribute to the quality of decision-making and will therefore have a significant impact on the economic participants, such as individuals and businesses, the immediate environment and the economy as a whole (Mangochi, 2000). In our competitive world, one of the most convenient ways of gathering information is via the Internet. Unfortunately, there is the misconception that all the countries in the world are connected and that every country has access to information. The reasons for this disparity include extreme poverty, the lack of a reliable infrastructure, costs that are unaffordable to the majority of the population, and the lack of personal computers, Internet awareness and computer illiteracy (Sarrocco, 2002).

Although the number of Internet users in South Africa is increasing, it is increasing at a diminishing rate. This may suggest that those wanting access to the Internet and having the financial means have already obtained access. Ultimately, this still leaves the majority of the population with no access to the Internet and therefore these individuals remain marginalised and unable to participate in an information-based economy. Given the numerous factors that affect Internet usage, the aim of this paper is to capture some of the domestic determinants of Internet usage in South Africa through the application of the three-step Engle and Yoo cointegration procedure.

This paper is set out as follows: the first section provides a brief overview of Internet usage in South Africa, followed by definitions of the domestic digital divide and descriptions of the determinants of the domestic divide. A simple theoretical model of the number of Internet users for South Africa is then estimated, and finally some policy implications, in particular tax relief and skills development, are discussed.

1. OVERVIEW OF INTERNET USE IN SOUTH AFRICA

South Africa is seen as the powerhouse of Africa and has the largest number of mobile phone subscribers in Africa. According to the World Economic Forum, South Africa is ranked first on the Technology Index, third on the Macroeconomic Environment Index, fifth on the Public Institutions Index and third on the overall Growth Competitiveness Index on the continent (World Economic Forum, 2004). In addition, Africa has the highest ratio of Internet subscribers to fixed telephone lines in the world. This implies that with the shift towards mobile phones for voice communication, the demand for fixed telephone lines is mainly driven by the demand for dial-up connections in order to access the Internet (Anon, 2002b).

In 1991 South Africa became the first African country to be connected to the Internet with a total of 10 000 people accessing the Internet (World Bank). Although this number has increased drastically in the last decade, the last few years have been characterised by a decrease in the growth of Internet access in South Africa. A study by Arthur Goldstuk from World Wide Worx (World Wide Worx, 2002) estimates that in 2001, 2.89 million South Africans had access to the Internet, revealing that only one in 15 people accessed the Internet. In 2002 this number had increased to 3.1 million users, which represents approximately a 7 per cent growth for that year. This growth figure was significantly lower than previous years. In 2003 the estimated number of Internet users grew by only 6 per cent to 3.28 million, implying that one in every 13 South Africans accessed the Internet. The main factors that have been sited for this disappointing performance include the markets' ignorance about the value of the Internet, the delays in licensing a second network operator and the high cost of Internet access (World Wide Worx, 2002). The poor performance of the 2001-2003 period was followed by a significant increase in the number of Internet users in 2004. According to Arthur Goldstuk, the number of Internet users is expected to be approximately 3.52 million, implying that at the current rate of growth, one in 10 people will have access to the Internet by 2006 (World Wide Worx, 2002). The good performance in 2004 was mainly due to the following factors: a licence was granted to a second network operator improving market competitiveness, and the stronger rand brought down the cost of equipment used in infrastructure improvement. Internet access in schools also increased as a range of long-awaited projects reached fruition (World Wide Worx, 2003). The latest Goldstuck Report states that approximately 3,6 million South Africans will have access to the Internet at the end of 2005. This implies that one in every 12 South Africans has access to the Internet, marginally up from one in 13 at the end of 2003 (World Wide Worx, 2005).

2. DEFINING THE DIGITAL DIVIDE

The digital divide can be defined in various ways. The narrow definition refers to the lack of access to computers between racial groups. The broad definition includes sufficient training and the relevant content of the information on the Web that will enable different age groups, genders and regions to use technology effectively (Anon, 2001a). Some argue that the divide is merely a lack of physical access and training. Solving this problem is fairly straightforward: provide access and training. At the other end of the spectrum, it is defined as the reflection of a more complex problem that mirrors widespread illiteracy, poverty, health and other socio-economic and political issues. Thus, addressing this problem goes far beyond only providing access and training. The African Competitiveness Report states that "while telecommunications infrastructure plays a crucial part, it is equally important to have a stable and developed infrastructure in the financial, transport and fiscal sectors as well as effective power and water distribution. For some countries, provision of these more basic needs will remain a priority and progress towards e-readiness is dependent on building stable infrastructure across these sectors" (World Economic Forum, 2004). Bridging the digital divide will therefore include a critical re-evaluation of policies such as education, income distribution and health. Another argument states that the divide represents a lost opportunity, where the underprivileged are unable to take advantage of technology and therefore remain in a vicious cycle of poverty. Finally, the digital divide is seen as a lack of access and training, but as market competition increases and selective programmes are implemented, technology will become more affordable for the poor. In other words, the divide will in time correct itself (Anon, 2001a).

A different understanding of the digital divide is to analyse why the divide exists. It is generally acknowledged that wealthier countries can afford to experiment with and adopt new technology. As these technologies become less expensive, they will be adopted by poorer nations. Therefore, the divide occurs because of the naturally slow diffusion of technology. Another argument is that access may be provided to potential users, but they either do not want or do not know how to use the technology and can therefore not reap the benefits thereof (Anon, 2001a).

2.1 Domestic divide – the division within countries

The domestic divide is defined as the disparities regarding the access and use of Information Communication Technology (ICT) that exists between groups within a country. A report by Bridges.org entitled *Spanning the digital divide: understanding and tackling the issues*, states that within countries the global overall trend shows that all groups are increasing their access and use of ICT, and that for some technologies such as personal computers and mobile phones, saturation levels have been reached. It would therefore appear as if the divide between the "haves" and "have-nots" is decreasing. However, the "haves" are increasing their use and access of ICT at such an exponential rate that the divide is growing. With the introduction of improved technology, it will be

the “haves” that will be able to afford, acquire and effectively use new technology, and therefore increase their benefits and advantages even further (Anon, 2001a). This is evident in the South African environment. With the introduction of high-speed Internet access in South Africa, the impact was felt much stronger by the existing users rather than new Internet users because existing users were migrating from dial-up usage to high-speed access (World Wide Worx, 2005). The following factors have played a role in the degree to which technology is accessed.

2.1.1 Race

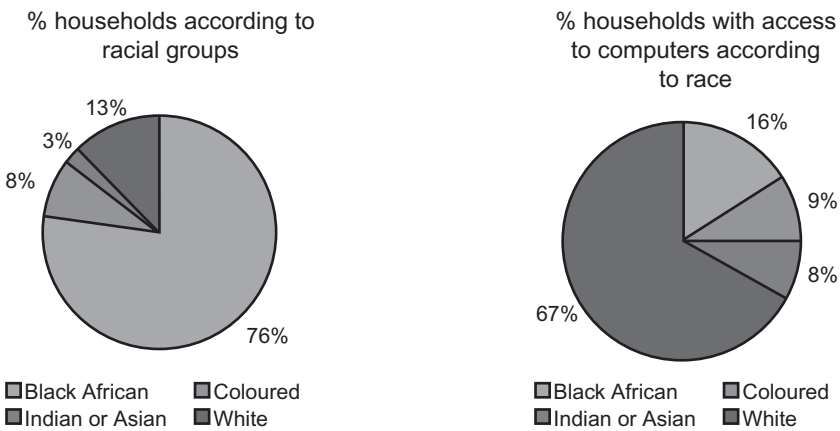
The world trend suggests that all population groups are increasing their Internet access, but that some groups are using the Internet more effectively. In the United States it appears that different racial groups use the Internet to different degrees. The white population, at 50.3 per cent, continue to be the most likely to use the Internet, followed by the Asian American/Pacific Islanders and black population groups at 49.4 per cent and 29.3 per cent respectively. Finally, the population group least likely to access the Internet is that of Hispanics at 23.7 per cent (United States Department of Commerce, 2000). A study based on 2001 census data of Internet access in New Zealand indicated that households containing at least one person of Asian ethnicity had the highest level of Internet access, with 58 per cent of households connected. In contrast, households with Pacific people were less than half as likely (23 per cent) to be connected to the Internet (Statistics New Zealand, 2004).

In South Africa a study by Webchek (1999) found that only 0.125 per cent of black women had Internet access at home compared to 0.6 per cent with access at work, and less than 1 per cent had computers at home compared to 2.9 per cent who had a computer at work. Of the black men interviewed, 0.1 per cent had access to the Internet at home and 1.2 per cent had access at work with 1.3 per cent owning a computer at home compared to 4.7 per cent who had access to a computer at work (Webchek, 1999a).

In 2000 the picture for black women has not changed much. A study by Webchek (2000) shows that there was no growth in the number of black women with personal computers and Internet access from May 1999 to May 2000. However, the percentage of white women with personal computers and access to the Internet increased from 31.8 per cent in May 1999 to 34 per cent in May 2000. Internet access at home increased from 7.4 per cent to 10.6 per cent (Webchek, 2000b). Access to personal computers and Internet at home has increased slightly for black men from 1.2 per cent in 1999 to 1.4 per cent in 2000. White men fared much better regarding access to personal computers and Internet at home. In 2000, 37.4 per cent of white men had personal computers and access to the Internet at home compared to 35.6 per cent in 1999 (Webchek, 2000b).

The above statistics for South Africa seem plausible. According to the 2001 census, the population in South Africa amounts to 44.8 million people and can be divided into four basic racial groups. Black South African's represent the largest population group at 79 per cent and the Indian or Asian group the smallest, representing 2.49 per cent of the population. South Africa seems to follow the world trend, as there appears to be a great disparity in computer access between racial groups. Figure 1 clearly shows that although Black African households account for approximately 76 per cent of total households, only 16 per cent have access to computers, compared to white households making up an estimated 13 per cent of total households with 67 per cent having access to computers.

Figure 1: Households divided according to racial groups and access to computers



Source: Statistics South Africa, census 2001

2.1.2 Income

Income has been identified as the most important factor in determining Internet access. In the United States all income groups are increasing their access to the Internet, but those who fall in the highest income group increased their access to the greatest degree. Only 18.9 per cent of individuals who lived in households with annual incomes of less than $15 000 were Internet users compared to 70.1 per cent of people who lived in households where the annual income was greater than $75 000. Even though a small number of people in the low-income group accessed the Internet, they registered the highest growth rates (United States Department of Commerce, 2000).

A study in New Zealand found that 72 per cent of the households reporting an annual income greater than $100 000 had access to the Internet. This high income group is five times more likely to have access to the Internet compared to 14 per cent of the households who reported an annual income of less than $15 000 (Statistics New Zealand, 2004). In the Chilean case, access to computer and Internet differentials could be explained by income, education, geographical factors and gender. Surprisingly, age did not play a role in determining Internet access. This study found that if income increased by ten thousand Chilean pesos, the odds of being a full or partial user of ICT increased by 67.2 per cent and 48 per cent respectively (Flores, 2003).

According to the Census 2001 data, 54 per cent of the labour force in South Africa earn less than R1 600 per month compared to 0.1 per cent earning more than R204 801 per month. Of the 0.1 per cent earning more than R204 801 per month, 73 per cent were white and 19.5 per cent African. Only 12.7 per cent of the labour force earn above R6 401 and 88 per cent of those earning less than R400 a month are African (Business Report 10 Years).

2.1.3 Geographical location

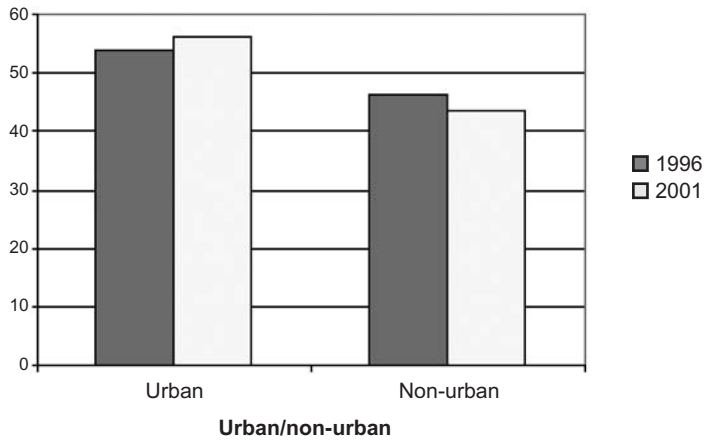
Major cities are more likely to provide the necessary infrastructure for telephones, computers and the Internet. This would leave the rural areas either underserved or with an unreliable infrastructure. As certain "older" well-established technologies become available and affordable, it would appear as if the divide is decreasing, but when new technology is introduced, the rural-urban divide will remain. Zappacosta (2001) states that "in developing countries as well, ICT's are considered important drivers of change, offering a new window of opportunity". Nonetheless, these opportunities are distributed unevenly between urban and rural areas. In fact they tend to converge and concentrate in urban areas, where there is a better infrastructure, skilled human resources and people with higher purchasing power.

In contrast, rural areas, the weakest side of the 'digital divide', are mainly unconnected and often experience further marginalisation" (Zappacosta, 2001). In Nepal, 84 per cent of the population live in rural areas and depend on subsistence farming. In 2002 there were 1.61 main telephone lines per 100 people in Nepal. Of this, only 1.64 telephone lines per 1000 people served the rural population. It is therefore not surprising that only major cities have access to the Internet and that only 26.39 people in every 10 000 can access the Internet (Vaidya, 2003). In the case of Chile, the geographical area of residence also affects the odds of accessing the Internet and computers. Workers from non-metropolitan areas are almost 42 per cent less likely to access the Internet or computers than workers from metropolitan areas (Flores, 2003).

The 2001 census data indicates that most of the South African population reside in urban areas. Figure 2 indicates that in 2001 over 56 per cent of the people lived in urban areas compared to

the 1996 census statistics where 53 per cent lived in urban areas.[1] In 2003 a study on Internet access in rural South Africa showed that an estimated 3 per cent of the sample had access to the Internet, 1 per cent of which had access at home and 2 per cent had access at work. The study also indicated that 10 per cent of the sample had access to the Internet, with 6 per cent having access at home and 7 per cent at work (Webchek, 2003).

Figure 2: Percentage of population size: urban and non-urban



Source: Statistics South Africa, census 1996 and 2001.

2.1.4 Education

Access to computers and the Internet is highly correlated with education. Higher levels of education would imply that one is more likely to have access to computers and the Internet - both at work and at home. It should be noted that education is also correlated with income and citizens in higher income groups will therefore be more likely to purchase technology and use it effectively.

An Australian study showed that 41 per cent of those with a university education used the Internet compared to only 6 per cent with a secondary education (Australian Broadcasting Authority, 2000). In the United States, Internet use rises with higher levels of education. Less than 4 per cent of adults with only an elementary level of education had access to the Internet compared to 74.5 per cent of those with a minimum education of a bachelor's degree (United States Department of Commerce, 2000). In New Zealand, education was the second most important factor after income determining access to the Internet. Sixty-eight per cent of households where at least one person had a university degree had access to the Internet compared to 46 per cent with a vocational

[1] *Estimated total population in 1996 was 40 583 572, 21 781 807 (53.67%) of which live in urban areas and 18 801 765 (46.33%) live in non-urban areas. Estimated total population for 2001 was 44 819 778, 25 230 527 (56.29%) of which live in urban areas and 19 589 251 (43.71%) live in non-urban areas.*

qualification and 36 per cent with a school education. Twelve per cent of households where no one had a qualification were connected to the Internet (Statistics New Zealand, 2004).

2.1.5 Age

In general, people between the age of 35 and 45 are more likely to use available technology. In the United States, an Internet access rate for the age group 9 – 17 was estimated at 53.4 per cent and for the age group 18 – 24, 56.8 per cent. For the age group 24 – 49 it appears as if labour force participation is an important factor. For this group, the overall Internet access rate was 55.4 per cent. Those who are employed are more likely to have access to the Internet (58.4 per cent) compared to 39.3 per cent for the unemployed. For the age group over 50, only 29.6 per cent are Internet users and are almost three times more likely to access the Internet if they are employed (United States Department of Commerce, 2000).

Webchek conducted a study to determine the inclination of non-users of computers to gain access to computers and the Internet at home. This study found that people between the age of 35 and 49, with children and earning a monthly salary of between R10 000 and R15 000, are more likely to have access to a computer and Internet at home, than people older than 50, with no children and earning less than R4000 per month (Webchek, 2000b). This study also found that although two thirds of the participants have computers at home, they are not connected to the Internet. Most claim that costs are a major restraint.

2.1.6 Gender

The overall trend shows a disparity between men and woman in terms of Internet access. In Africa, it is more likely that men have access to the Internet. For example, in Ethiopia, Senegal and Zambia, 86 per cent, 83 per cent and 64 per cent respectively of Internet users are men. In the Middle East, only 4 per cent of women access the Internet, compared to the OECD counties where the disparity between men and women is much smaller (Anon, 2001a). In the United States more women tend to access the Internet than men, although the division is greater for those who are employed. For the age group 7 – 19, there is little difference in the percentage of women (53.9 per cent) and men (52.9 per cent) who access the Internet. For the age group 18 – 24, more women (59.6 per cent) access the Internet than men (54.1 per cent), and among the age group 25 – 49 who are employed, 60.8 per cent are women and 56.2 per cent are men. For the unemployed who fall in this age group and have access to the Internet, 42.6 per cent are women and 28.6 per cent men (United States Department of Commerce, 2000).

In 2001, Webchek conducted a study on Web usage in South Africa. The study found that both men and women use the Internet more at work than at home and that significantly more men access the Internet and spend more time online than women. Men tend to buy more items online and do their banking online (Webchek, 2000c).

3. THEORETICAL MODEL

Based on world trends, the model specification includes the following variables:

Internet users = function of (personal computers, wage and salary, other variables)
(+ + ±)

with Internet users = log(Internet users)
pc = log(personal computers)
wage = log(real wage and salaries)
other variables include pop density = log(population density)
gov spending = log(government spending on education)
mainlines_emp= log(telephone mainlines per employees)

The above equation indicates a long-run relationship between the number of Internet users, personal computers and real wages and salaries. Other variables that can affect Internet usage in the short run are geographical location and government spending on education and infrastructure. It is very likely that the number of Internet users will increase as access to personal computers increases, especially if an individual is employed. Likewise, if real wages and salaries increase, technology may be more affordable and therefore a positive effect on access to Internet is expected.

The inclusion of the above variables is based on previous research done by research institutes (Bridges.org, Webchek), government departments (United States Department of Commerce) and Statistical Departments (Statistics South Africa and New Zealand).

4. THE DATA

The data used to estimate the number of Internet users in South Africa was taken from the World Bank Development Indicators (World Bank). Table 1 reports the series used in this estimation. The only transformation made was to the real wage and salaries series. This series is an index that was base-shifted from 1980 to 1995.

The sample period begins in 1991, as this was the year in which South Africans first accessed the Internet. The sample ends in 2001, which has the last recorded data. It is acknowledged that the relatively small sample size (eleven period observations) limits a detailed analysis of the factors that determine access to the Internet. However, given this limitation, it should be kept in mind that the variables included in this model have been identified as probable determinants.

Table 1: List of variables

Series	Abbreviation	Description
WDI;ZAFITNETU	internet	Technology: Internet users
WDI;ZAFITCMP	pc	Technology: Personal computers (Unit: per 1 000 people)
WBA;ZAFGBXCWA8	wage	Real wages and salaries (Unit: Index 1980 = 100)
WDI;ZAFENRUR	pop_density	Population density, rural (Unit: people per sq km)
WDI;ZAFSEXTLD	gov_spending	Public spending on education, total (Unit: % of GDP)
WDI;ZAFITMEMPL	mainlines_emp	Telephone mainlines per employee

Tests for stationarity were subsequently performed. Data plots for the different variables indicate that the Internet, personal computers and telephone mainlines have a definite upward trend. Real wages and salaries drastically increase from 1991 to 1992 and thereafter gradually increase over time. Population density clearly decreases over time, suggesting that the majority of the South African population resides in urban areas.

From the results of the Augmented Dickey-Fuller tests for non-stationarity, it appears as if the variables are integrated to the order one. This means that the series should be differenced once in order to render stationarity. Stationarity implies that the statistical properties (mean, variance and co-variance) of the series are not constant over all the observations. It should however be kept in mind that the sample size is limited and therefore the power of the test may be low. This may imply that there is a tendency to over-reject the null hypothesis.[2] For the purposes of this study, the series is assumed to be integrated of the order one and the next step is to test whether a long-run relationship exists between the variables.

5. THE ESTIMATION RESULTS OF THE COINTEGRATED MODEL

The Engle and Yoo three-step estimation technique is used. The first step is to test a set of variables for cointegration, that is to test whether there is a long-run relationship between specific combinations of variables. The cointegration results for the first step are reported in Table 2.

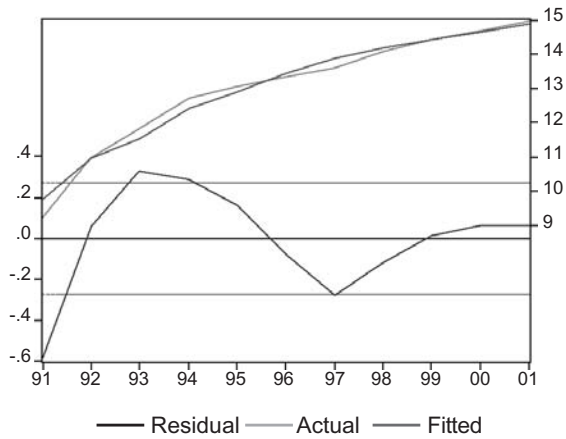
Table 2: The first step estimation results, dependent variable: log_internet $_t$

Variable	Coefficient	Std.Error	t-Statistic	P-value
log_pc$_t$	2.092210	0.144677	14.46128	0.0000
log_wage_salary$_t$	1.283776	0.109755	11.69679	0.0000
R-squared	0.978054			
Adjusted R-squared	0.975616			

[2] H_0: *Non-stationarity*
H_1: *Stationary*

The coefficients of the cointegration equation can at this stage not be interpreted as they are biased and the t-statistics have a non-standard distribution. We can however evaluate the signs of the variables. The positive signs of the personal computers and the wages and salaries variables are consistent with economic theory. Figure 3 compares the actual values with the fitted values generated by the cointegration equation.

Figure 3: The cointegration equation: actual, fitted and residual values



The ADF test is a unit root test performed on the residuals of the cointegration equation. The Augmented Dickey-Fuller (ADF) test statistic is –4.605876. The ADF statistic is compared to the MacKinnon[3] critical value of –4.04222 indicating that the null hypothesis of no cointegration can be rejected on a 10 per cent level of significance. The residuals can therefore be accepted as stationary and the equation in Table 2 represents the long-run equilibrium equation for log(internet). The short-run fluctuations around this equilibrium can now be modelled with an error correction model.

6. THE ERROR CORRECTION MODEL

The short-run dynamics are estimated in step 2 of the Engle and Yoo estimation technique by means of the error correction model (ECM). This model includes the lagged residual term estimated in the cointegrated estimation as well as variables that explain the short-run variance in the dependent variable. A summary of the results is provided in Table 3.

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[3] The MacKinnon critical value can be calculated as $C(p) = \phi_\infty + \phi_1 T^{-1} + \phi_2 T^{-2}$ *where* $C(p)$ *is the* p *per cent critical value.*

Table 3: The error correction results, dependent variable: Δ log_internet $_t$

Variable	Coefficient	Std Error	t-Statistic	P-value
Residual $_{t-1}$	-1.352998	0.077990	-17.34841	0.0000
Δ log_pc $_t$	1.734913	0.168165	10.31675	0.0001
Δ log_pop_density $_t$	-32.71902	2.946040	-11.10610	0.0001
Δ log_gov_spending $_t$	1.878648	0.363273	5.171449	0.0036
Δ log_mainlines $_t$	0.506175	0.255759	1.979112	0.1047
R-squared	0.990974			
Adjusted R-squared	0.983754			

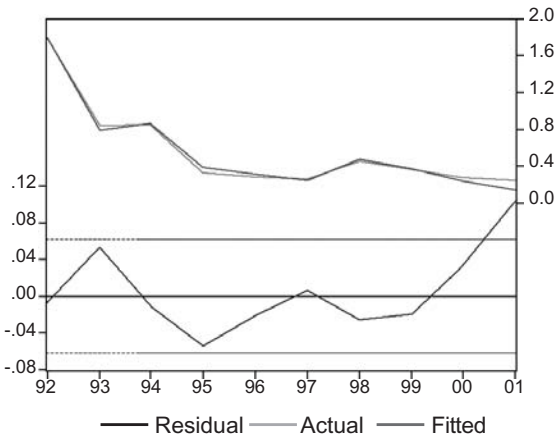
The ECM includes the differences of the variables and therefore the signs and magnitudes cannot be evaluated. However, the statistical significance of the variables can be evaluated. It appears as if the variables are statistically significant since the probabilities are less than 0.1 and the t-statistics of the variables are greater (in absolute terms) than 1.96. The adjusted is 0.983754 and suggests that 98 per cent of the variation in the number of Internet users can be explained by the explanatory variables.

As discussed previously, income differentials can almost completely explain the different degrees of Internet access. As income increases, the costs associated with the access and use of technology become more affordable and therefore access to the Internet will improve. A person who owns or has access to a personal computer is more likely to have access to the Internet.

Government spending on education and infrastructure will have a positive effect on obtaining access to the Internet. Since the degree of Internet access depends on the level of education, a higher qualification will enable a person to gain employment and therefore stand a better change of having access to a personal computer and the Internet. Government spending may include the provision of personal computers in education. This will not only introduce students to the Internet but also equip them better with the necessary skills to use this technology effectively.

It is acknowledged that urban areas have better and advanced infrastructure, making access to the Internet much easier. It is therefore logical that people living in rural areas might find it more difficult to access the Internet. Therefore, one would expect that as the population density in the rural areas increases, access to the Internet would decrease. The number of telephone mainlines per employee is indicative of the level of infrastructure. As the infrastructure is improved, so will access to the Internet. A data plot of the actual and the fitted values of changes in Internet usage is shown in Figure 4.

Figure 4: The actual, fitted and residual values of Δ Internet



Several diagnostic tests[4] were performed on the ECM to determine whether the classical assumptions were violated. It should be kept in mind that the conclusiveness of these tests is reduced due to the relatively small size of the sample. The tests suggest that the classical assumptions are not violated. Since the diagnostic test results are statistically acceptable, the next step is to adjust the cointegration coefficients and t-values. The third step in the Engle and Yoo procedure is performed.

7. COINTEGRATION CORRECTION AND ADJUSTED COEFFICIENTS

In the next section, the long-run coefficients and the t-values are adjusted so that the coefficients are unbiased and the t-values have a standard distribution. The adjustments are made by regressing the coefficient of the residuals in the error correction model with the variables in the long-run equation. The results indicate that the long-run coefficient of the personal computer variable should be adjusted with 0.012184 and wages and salaries adjusted with –0.008276. The adjusted personal computer coefficient is 2.104394, while that of wages and salaries is 1.2755. Both these variables are significant with t-statistics greater than 1.96 in absolute terms.

The coefficients are now corrected and can be interpreted. The model estimating the number of

[4] Diagnostic test results

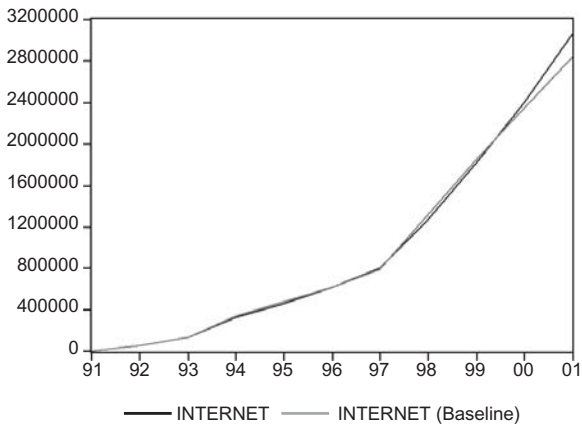
Purpose of test	Test	Test statistic[4]	P-value
Normality	Jarque-Bera	JB=1.42848	0.489564
Heteroscedasticity	ARCH	$nR^2(1)$=0.07771	0.780419
Serial correlation	Breusch-Godfrey LM	$nR^2(1)$=1.04540	0.306569
Stationarity of residuals	Lung Box Q	Q(6)=7.94840	0.2420
Specification	Ramsy RESET	LR(2)=0.12209	0.940779
Parameter stability	CUSUM, CUSUM of squares, Recursive estimates, Recursive residuals	All indicative of stability	

Internet users in South Africa can be written as:
Internet users = 2.104394pc +1.2755 wage and salaries + error term

The above equation implies that a 1 per cent increase in personal computers leads to a 2.10 per cent increase in the number of Internet users, and a 1 per cent increase in real wages and salaries will lead to a 1.2755 per cent increase in the number of Internet users. Both these arguments are consistent with the world trends and economic theory.

This was the final step in the Engle and Yoo estimation procedure, and the final model is obtained by combining the long- and short-run characteristics. The overall fit of the model is depicted in Figure 5.

Figure 5: The actual and fitted values of Internet



8. DYNAMIC RESPONSE PROPERTIES

The above Internet model was subjected to sensitivity testing. The dynamic simulations will determine whether the resulting multiplier effects are consistent and therefore whether the model is stable and robust. It will also reveal some of the policy implications of the model. The dynamic response properties and some policy implications are discussed in the next section.

8.1 Sensitivity tests

The wage and salaries, and personal computers variables were shocked one at a time. Firstly, a 10 per cent shock was applied to the wages and salary series, allowing the wages to increase 10 per cent above the baseline level from 1994 onwards. It is expected that if real wages increase and individuals' purchasing power increases, the consumption of goods and services will increase. This will include the consumption of capital goods such as personal computers and their related functions. Secondly, a 10 per cent shock was applied to personal computers, allowing the access and ownership of personal computers to increase 10 per cent above the baseline level from 1994 onwards. It is expected that an increase in access to personal computers would increase access to the Internet.

It was considered appropriate to begin with the two shocks in 1994. The shocks could not be applied later, because the size of the sample is limited and sufficient time should be allowed for the effect to develop. Table 4 indicates the divergence in the long-run equilibrium value of the Internet variable by the end of the sample period, 2001.

Table 4: Difference between the baseline forecast and forecasts with shocked variables, dependent variable: Internet

Variable	Coefficient	Expected change in internet	Actual divergence in internet in 2001
wage_salary	1.2755	0.12755	0.12936
pc	2.1043	0.21044	0.22227

The results of the sensitivity test in Table 4 are shown in Figures 6 and 7.

Figure 6: Dynamic adjustment properties (in percentage change) with a 10 per cent increase in real wages and salaries, dependent variable: Internet

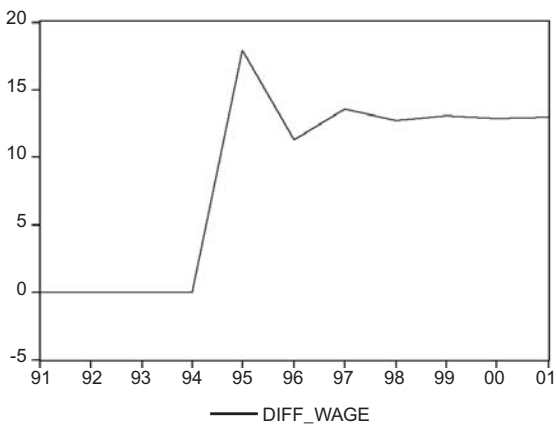


Figure 6 shows that a shock to real wages and salaries in 1994 results in a sharp increase in the number of Internet users, amounting to a maximum of just over 17 per cent in 1995. This is followed by a large decline in 1996 to approximately 12 per cent followed by a relatively smooth adjustment path towards a new long-run equilibrium which, by the end of 2001, stabilized around 3 203 129 Internet users compared to the baseline forcast of 3 068 000. This constitutes an increase of 12.93 per cent. The initial response of a real wage and salary shock is consistent with what was expected.

Figure 7: Dynamic adjustment properties (in percentage change) with a 10 per cent increase in the number of personal computers, dependent variable: Internet

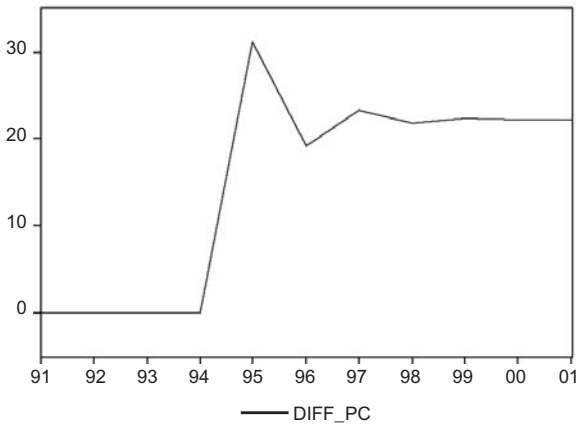


Figure 7 shows that a shock to personal computers in 1994 results in a sharp increase in the number of Internet users, amounting to a maximum of just over 30 per cent in 1995. This is followed by a sharp decline in 1996 to approximately 19 per cent followed by a relatively smooth adjustment path towards a new long-run equilibrium which, by the end of 2001, stabilised around 34 667 020 Internet users compared to the baseline forcast of 3 068 000. This constitutes a forecast increase of 22.22 per cent.

9. POLICY IMPLICATIONS

The South African government has implemented a number of policies aimed at increasing income and skills development, and creating equal opportunity within the formal employment market, which would contribute to achieving broad access to available technology. Since 1994, there has been a clear shift from a priority defence budget towards a budget emphasising social development and addressing the numerous disparities that exist between and within the different racial groups. The past couple of years were witness to significant adjustments regarding government revenue and expenditures. The personal income tax rate and threshold have been restructured in such a

manner that all taxpayers benefit from personal income tax relief. Most notably, the tax burden on low-income earners has been reduced (Budget Review, 2005).

The 2005 tax proposals are "designed to support sustained investment and economic growth, contribute to social equity and promote job creation in the small business sector" (Budget Review, 2005). Although the tax system has been restructured, the gap between the rich and the poor remains significant. The uneven distribution of income seems to be, among other things, mirrored in the access to technology. A report by Bridges.org (2001) states that within countries, all groups, even the poorest, are also increasing their access to, and use of, ICT. But within countries, the "information haves" are increasing access and use at such an exponential rate that, in effect, the division within countries is also actually growing. The argument is that a reduction in personal income tax leads to an increase in disposable income. Although an increase in income is necessary for increasing access to technology, such as the Internet, it is not sufficient. It may cause an increase in the demand for goods and services, favour economic growth and increase employment opportunities. However, by stimulating the economy from the demand side, inflationary pressures may occur, which could result in a reverse of the current fiscal policy objective.

Some straightforward policy observations may be constructed from the sensitivity tests performed in the previous section. According to the sensitivity tests, it seems as if an increase in real wages and salaries is necessary, but not sufficient in addressing the issue of Internet access. A 10 per cent shock in real wages and salaries will increase the number of Internet users by 12.93 per cent in the long run. Compare this to a 10 per cent increase in access to personal computers, which causes a 22.22 per cent increase in Internet access in the long run. In other words, there is no guarantee that access to the Internet will improve if only wages and salaries improve. This could imply that the disparities in South Africa in terms of access to basic services are so great that the "have nots" will first attempt to improve their immediate environment before they address issues such as technology. What is necessary is that adequate infrastructure, policy implementation, the regulation of the ICT sector and opportunities to improve skills should play an equally active role as income in addressing the information gap. The skills development fund was established "to provide funding for the training and upgrading of skills levels of the workforce" (Budget Review, 2005). Among the purposes of the Skills Development Act (South Africa Department of Labour, 1998) is the development of the skills of the South African workforce, and the encouragement of employers to use the workplace as an active learning environment, and to provide opportunities for employees to acquire new skills. Since small and medium enterprises are viewed as the engine of employment opportunities, it is important that employers view the Skills Development Act and Setas as an opportunity to improve their employees' skills and productivity. It is not only a tool to improve productivity, but if the employees become redundant, a number of opportunities exist so that they can be re-trained and find alternative employment in the current information age. A concern, however, is whether small businesses still qualify for skills development funding if they

are exempt from this levy. Ivor Blumenthal, the Services Seta CEO, said that from August 1 "Setas will only benefit medium to large companies. Small businesses will now lose out on billions of rands of developmental and supply-side grants and other benefits from Setas" (Business Day: 2005). This seems to be directly in contrast with the outcomes that the government wants to achieve in terms of skills development. Although the Setas have been criticised for their "inability to disburse monies, cumbersome bureaucracies, failure to reach targets, the slow pace of progress, and the failure to reach the poor and unemployed", these institutions play an important role in addressing the skills shortages in South Africa, by equipping and empowering the marginalised. Care should be taken not to achieve the opposite of this well-intended policy objective to the detriment of those who should ostensibly benefit.

CONCLUSION

In addressing the numerous problems in South Africa, it is imperative for appropriate technology to be used to increase the effectiveness of policy implementation and government service delivery. A specific challenge is to include the previously disadvantaged population in a competitive market economy. This is possible, provided that this group has access to information and communication technology. This paper attempts to measure the determinants of Internet usage in South Africa. The results indicate that access to personal computers and an increase in real wages and salaries will have a long-run positive effect on Internet usage. Other variables that are significant are population density, and government spending on education and infrastructure.

The results indicate that personal computers yield a significantly larger increase in access to the Internet than real wages and salaries. This could imply that the disparities in South Africa in terms of access to basic services are so great that the "have nots" will first attempt to improve their immediate environment before they address issues such as technology. In today's competitive environment, information is a necessity, but basic needs are generally satisfied (first) before issues such as technology become important.

Significant tax reforms have been implemented since 1994. Individuals and businesses benefit from tax relief and, notably, the tax burden on low-income earners has been reduced. This leaves the poor with more disposable income with which necessities can be financed. But as shown, an increase in wages is not sufficient – access to personal computers and skills is equally important.

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