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Estimating the Impact of Information Technology on Poverty Reduction in Pakistan

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Abstract

Nations that under-estimate the importance of Information and Communication Technology (ICT) are lagging behind, in their economic perspectives as compared to the developed ones. The objective of this paper is to examine the potential impact of information technology on poverty reduction, in special context of Pakistan. Data set from 1980–2009 are taken for time series analysis. Following three parameters are established: a) information technology and poverty are non-stationary series, b) they are co-integrated and c) the error-correction term is significant with an adjustment coefficient of -0.713. The results indicate that increase in usage of ICT decreases poverty by almost 3% in the short-run. While in long-run, a positive relationship is established between ICT, economic growth and poverty.

Keywords: Average Household Income, Cointegration, Vector Error Correction, Pakistan.

Introduction

Information and Communication Technology (ICT) plays a main role in all phases of state-run existence i.e., in politics, economic life, as well as in collective and literary development. It is speedily transforming our lives, the way we do commerce, access information and services that communicate with each other and consider ourselves. It stimulates the global economy and relates to human rights, to support freedom of expression and right to information [Universal Declaration of Human Rights-Article 19].

Poverty is multidimensional phenomena. It is exemplified as lack of income and non-fulfillment of basic needs as by lack of access to social infrastructure and vulnerability. Poverty in Pakistan is a rising concern. The middle-class has grown in Pakistan to almost 35 million; nearly one-quarter of the population is classified poor as of October 2006 which is mention in economic survey of Pakistan 2007-08. The declining trend in poverty as seen in the country during the 1970s and 1980s was reversed in the 1990s by poor federal policies and rampant corruption.[1]

A view widely held in the sphere of development economics is that the benefits of economic growth distribute automatically across all segments of society. This is in reality, the well known trickle down hypothesis, which was a foremost thinking in the 50s and 60s. In a similar manner, the outcomes derived from a number of recent studies suggest that economic growth in general reduces poverty. Among these studies, Dollar and Kraay's (2002) paper has attracted much consideration.

The matter is, whether economic growth jointly with the ICTs will decrease poverty. The relationship between growth and poverty is multifaceted and depends largely on the inequalities and initial conditions that favour or discourage the distributional effects of growth (Ravallion and Datt 1999). According to Birdsall (2002) the global economy can be heaped against the poor. In particular, the countries that are caught in an "institutional poverty trap" will not necessarily benefit from a strong global market. The same applies to the regions.

According to Kenny et al. (2001) and Feinstein & Picciotto (2001); poverty stems from situations where gross inequality in the rights of assets endures because of vested interests and fixed power structures. Markets can aggravate collusions that block the probable benefits of competition to the poor and the deprived easily fall outside distributional coalitions. Market, thus, can be prejudiced in favor of the more affluent and controlling social groups against poor and poor people often lack essential assets such as good productive resources and capital. Their employment circumstances is insecure and delicate, and their incomes seasonal. They live in remote, unhygienic and resource-poor areas, in distant villages and in atrocious slums. Their poverty results from lack of incomes, poor health and lack of education, lack of social safety nets, and discrimination. They also lack information, and suffer from poor government services and corruption. Support may also not reach them because of the lack of political will, poor governance and corruption, and inappropriate public policies and programs.

Poverty, thus, is an extremely complex socio-economic problem, that needs to be tackled concurrently in various sectors in order to disentangle the 'Gordian knot' of poverty. It is the synergy of combined efforts that produces the most sustainable results (Asian Development Bank 1999). Using ICT in detection of development goals allows countries to achieve a wide transmission of benefits, which will benefit broad-based economic growth, as well. (UNDP 2001 b). The objective of using ICT with marginalized groups, such as poor, is not only about overcoming the digital divide, but rather enforcing and furthering the progression of social inclusion, which is required for transformation of the environment and social system that reproduces poverty. Technology can assist in this process, but efforts should not be just limited to it (Warschauer 2002).

In reviewing the above studies, the empirical reliability of the information technology, growth and Poverty hypothesis is mixed and unfocused for the case of Pakistan. These sets of incoherent findings could be due to different sample periods and the diverse sets of econometric

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1 *http://en.wikipedia.org/wiki/Poverty_in_Pakistan* methodologies used such as single equation (OLS), vector autogression (VAR) model etc. For this reason, there is a prerequisite for employing the latest advances in dynamic time-series modeling within a temporal 'causal' framework that allows for the coexistence of both short and long-run forces that drive the often ignored deviating and cyclical influences so inherently interactive with these aggregate variables over such a time horizon.

The objective of the present study is distinct from other researches in a way that it applies cointegration and error-correction methods are employed which will obtain short- and long-run technology elasticities with respect to growth and poverty. For consistency of analysis and validity of statistical procedure we required a more direct measure of growth based on the same sample survey from which measures of poverty is derived. So we have settled for average household income distribution as an indicator of growth (G).

The paper is organized as follows. Section 2 explains the model and empirical methods. The data and empirical results are presented and interpreted in Section 4, and the final section contains the summary and conclusions.

Theoretical Model Formulation and Econometric Methodology

Theoretical model and data

The model used in this analysis is dictated by the typical formulation postulated by economic theory as:

$$\text{Log (IT)} = C + \log(G) + \log(P) + \varsigma_t \quad (1)$$

Where, IT represents the combination of number of public call offices and mobile phones (serves as a proxy for information technology); P represents the poverty (headcount Ratio); G represents average household income distribution (serves as a proxy for Growth) and ς_t is an error term assumed to be white-noise and normally and identically distributed.

The statistics used in this study comes from a Household Integrated Economic Survey (HIES), Pakistan Integrated Household Survey (PIHS), Pakistan Social Living Management (PSLM) Survey and Economic Survey of Pakistan, various issues, Federal Bureau of Statistics, Ministry of Finance and Pakistan Telecommunication Authority (PTA). Base-line for poverty is obtained from Economic Survey of Pakistan – 2010, where 2350 Calories are mentioned as cut-off point for Pakistan. A simple interpolation technique is to take the decline or inclined in trend between two points in time and fills the data gap between successive observations.

Econometric methodology

Like all other models that utilize time series data, it is essential to distinguish that unless the diagnostic tools used account for the dynamics of the relationship within a sequential 'causal' framework, the intricacy of the interrelationships involved may not be fully confined. For this rationale, there is a condition for employing the latest advances in time-series modeling. The following sequential procedures will be adopted as part as our methodology.

Univariate integration test

In order to verify to what degree these series share univariate integration properties, we perform both unit root tests and mean stationarity tests. The DF (Dickey and Fuller, 1979, 1981) type tests and the non-parametric Phillips-Perron (PP) type tests developed by Phillips (1987), Phillips and Perron (1988), and Perron (1988) are convenient testing procedures, both based on the null hypothesis that a unit root exists in the autoregressive representation of the time series. DF tests attempt to account for temporally dependent and heterogeneously distributed errors by including lagged sequences of first differences of the variable in its set of regressors. The PP tests try to account for dependent processes through adopting a non-parametric adjustment hence eliminating any nuisance parameters. Recently these tests have been shown (see Campbell and Perron (1991) and DeJong et al. (1992)) to suffer from lack of power as they often tend to accept the null of a unit root too frequently against a stationary alternative. Moreover, the Phillips-Perron statistics have been shown to perform poorly over small samples.

These studies have also implied that it would be worthwhile to conduct tests of the null hypothesis of mean stationarity in order to determine whether variables are stationary or integrated. Mean stationarity tests are performed with a test recently proposed by Kwiatkowski et al. (1992). This test (abbreviated as KPSS) is based on the statistic:

$$\eta(u) = (\frac{1}{T^2})\sum_{t=1}^{T} S_t^2 / \sigma_k^2 \text{ where } S_t = \sum_{i=1}^{t} v_i ,\ \text{t = 1, …..T} \quad (2)$$

with v_t being the residual term from a regression of y_t on an intercept, and σ^2 is a consistent long-run variance estimate of y_t and T represents the sample size. Kwiatkowski et al. (1992) show that the statistic $\eta(\mu)$ has a non-standard distribution and critical values have been provided therein. If the calculated value of $\eta(\mu)$ is large then the null of stationarity for the KPSS test is rejected. Since we entertain both the Phillips-Perron tests and the KPSS test in this exercise, we consider a variable to contain a unit root or be unit-root non-stationary if the null hypothesis of non-stationarity is not rejected by the PP tests but the null hypothesis that the variable is mean stationary is rejected by the KPSS test.

Multivariate cointegration test

The cointegration technique pioneered by Engle and Granger (1987), Hendry (1986) and Granger (1986) made a considerable input towards modeling stationary relationships while preserving the long-run relationship lost through differencing. Two or more variables are said to be cointegrated, i.e. they exhibit long-run equilibrium relationship(s), if they share common trend(s). According to this technique, if two variables are cointegrated, the finding of no causality in either direction is also ruled out. As long as the two variables have a common trend, causality (in the Granger sense, not in the structural sense), must exist in at least one direction either unidirectional or bidirectional (Granger, 1986, 1988). Evidence of cointegration among variables also rules out the possibility of the estimated relationship being 'spurious'.

In this analysis, the study employs the Johansen and Juselius (JJ) procedure of testing for the presence of multiple cointegrating vectors. Unlike its predecessor, the JJ procedure poses several advantages over the popular residual-based Engle-Granger two-step approach in testing for cointegration. Specifically, they may be summarized as follows. (i) The JJ procedure does not, a priori, assume the existence of at most a single cointegrating vector, rather it explicitly tests for the number of cointegrating relationships. (ii) Unlike the Engle-Granger procedure which is sensitive to the choice of the dependent variable in the cointegrating regression, the JJ procedure assumes all variables to be endogenous. (iii) Related to (ii), when it comes to extracting the residual from the cointegrating vector, the JJ procedure avoids the arbitrary choice of the dependent variable as in the Engle-Granger approach, and is insensitive to the variable being normalized. The JJ procedure is established on a unified framework for estimating and testing cointegrating relations within the VECM formulation. The JJ provides the appropriate statistics and the point distributions to test hypothesis for the number of cointegrating vectors and tests of restrictions upon the coefficients of the vectors. It is demonstrated in Johansen (1991) that the procedure involves the identification of rank of the m by m matrix H in the specification given by:

$$\Delta X_t = \delta + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-1} + \Pi X_{t-k} + \varepsilon_t \qquad (3)$$

where X_t is a column vector of the m variables, Γ and Π represent coefficient matrices, Δ is a difference operator, *k* denotes the lag length, and δ is a constant. If Π has zero rank, no stationary linear combination can be identified. In other words, the variables in X_t are non-cointegrated. If the rank *r* of Π is greater than zero, however, there will exist *r* possible stationary linear combinations and Π may be decomposed into two matrices α and β (each *m* × *r*) such that $\Pi = \alpha\beta^{/}$. In this representation b contains the coefficients of the r distinct cointegrating vectors that render 'X *t* stationary, even though X_t is itself non-stationary, and contains the speed-of-adjustment coefficients for the equation.

Application and Discussion of Results

Univariate integration: tests of the unit root hypothesis

Table 1 presents results from three tests discussed earlier on the three annual time series variables. It is quite clear to observe that for all variables the Phillips-Perron tests of the null hypothesis containing a unit root is quite small and cannot be rejected at conventional levels of statistical significance. This is true whether we allow for a deterministic trend to appear in the unit root test specification or not. On the other hand, the KPSS test statistic $\eta(\mu)$ that tests the null hypothesis that a particular variable is mean stationary is large for all variables and further confirms our earlier conclusion that these variables associated with a poverty model have a unit root and are clearly non-stationary in levels. However, once we take the first difference of these variables and apply the PP tests, all test values exceed the critical value (in its absolute value). This leads us to the conclusion that all series concerned are stationary in their first differences, while being non-stationary in their level form. In other words, we could not find any significant evidence that [IT, P, G] were not integrated of order one or 1(1).

Table 1. Results of the Unit Root Test

Variables	KPSS (constant)	KPSS (with trend)	ADF (constant)	ADF (with trend)	PP (constant)	PP (with trend)
IT	0.462**	0.172**	-1.857	-1.486	1.719	0.185
G	0.571**	0.164**	1.469	1.765	3.225	4.123
P	0.410***	0.120***	-1.354	-2.981	-1.241	-1.653

*Note: The KPSS test statistic tests the null hypothesis that the variable in question is mean stationary (the 5% critical value is provided in Kwiatkowski et al. (1992, p. 166, Table 1)). PP tests refer to the adjacent test carried out on the variable in first-differenced form. The statistics significant at 1, 5 and 10 % level of significance are indicated by *, ** and ***.*

Multivariate Cointegration

Given the common integrational properties of these variables, we then proceeded to test for the presence of cointegration in the vector [IT, P, G] by using Johansen and Juselius's multivariate procedure. Results of Johansen and Juselius's LR and trace tests are presented in Table 2.

Starting with the null hypothesis of no cointegration ($r=0, r \leq 1$) among the variables, the trace statistic of 34.41 and 18.13 exceeds the 95 percent critical value of the λ trace statistic (critical value is 29.79, 15.49). While, the null hypothesis of $r \leq 2$ cannot be rejected at 5 percent level of confidence. Consequently, we conclude that there are two cointegration relationship involving variables i.e., IT, G and P.

On the other hand, λ max statistic rejects the null hypothesis of no cointegration vector ($r=0, r \leq 1$) against the alternative ($r=1, r = 2$) as the calculated value λ max are 31.34 and 15.56 exceeds the 95 percent critical value (21.13, 14.26). Thus, on the basis of λ max statistic there are two co-integration vectors. The presence of cointegration vector shows that there exists a long-run relationship among the variables.

Table 2. Johansen's Test for Multiple Cointegration Vectors Cointegration (Test among IT, G, P)

H0:	H1:	Test Statistics	0.05 Critical Values	Prob. **
λ trace	Λ trace			
$r = 0*$	$r > 0$	34.41	29.79	0.009
$r \leq 1*$	$r > 1$	18.13	15.49	0.012
$r \leq 2$	$r > 2$	0.591	3.841	0.441

Note: Trace test indicates 2 cointegrating equations at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

Λ max Values		λ max Values		
$r = 0*$	$r > 0$	31.34	21.13	0.000
$r \leq 1*$	$r > 1$	15.56	14.26	0.034
$r \leq 2$	$r > 2$	0.653	3.841	0.113

Note: Max-Eigen Value test indicates 2 cointegrating equations at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

On the other hand, λ max statistic rejects the null hypothesis of no cointegration vector ($r=0, r \leq 1$) against the alternative ($r=1, r = 2$) as the calculated value λ max are 31.34 and 15.56 exceeds the 95 percent critical value (21.13, 14.26). Thus, on the basis of λ max statistic there are two co-integration vectors. The presence of cointegration vector shows that there exists a long-run relationship among the variables.

Short-run elasticities: VECM

For short-run parameter estimates, the present study moves to the vector error-correction model estimates which are presented in Table 3.

Table 3. Vector Error Correction Model (Dependent Variable: DLOG (IT)

Variable	Coefficient	t-statistic	Prob.
C	0.118	0.632	0.632
DLOG(IT(-1))	0.568	2.361**	0.049
DLOG(G)	-0.184	-0.892	0.451
DLOG(G(-1))	6.016	3.782*	0.004
DLOG(P)	-2.891	-3.571*	0.011
DLOG(P(-1))	0.792	-2.361**	0.043
Reside(-1)	-0.713	-3.469*	0.009
AR(1)	-0.516	-1.956***	0.091

R-square	0.763
Adjusted R- square	0.648
Durbin Watson	1.891
F-statistics	5.993*
Serial Correction	
LM 1	1.278
Functional form	
RESET	2.164
Heteroscedasticity	
Het	0.774
ARCH	0.845
Normality	
Jarque – Bera	2.015

The lag structure was specified using a general to specific approach. SSR refers to the sum of squared residuals. Distributional properties of diagnostics are respectively: LM(I) tests for the null of 1st order serial correlation amongst the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional heteroskedastic effects; RESET: Ramsey's Regression Specification Error/'-test with (m, n) degrees of freedom; and the Jarque-Bera X2(1) LM test for normality of residuals. *, ** and *** indicate significance at the 1, 5 and 10% levels respectively.

These results bring to light several features for inferences regarding the information technology in Pakistan over the sample. As can be seen, the coefficients appear to have the predicted signs and most of them are statistically significant. A general-to-specific approach was adopted in determining an appropriate lag structure. Further lagged dependent variables of IT were also tried but did not turn out significant and were therefore omitted from the regression.

The model also seems to be robust to various departures from standard regression assumptions in terms of residual correlation, Heteroscedasticity, autoregressive conditional Heteroscedasticity (ARCH), misspecification of functional form, or non-normality of residuals. This result tends to suggest that the impact of any structural change over the entire sample period, although could be evident, at least in terms of model stability, does not appear to be significant. The sign of the ECT coefficient indicates that changes in the technology adjust in an opposite direction to the previous period's deviation from equilibrium.

Summary and Conclusion

The intention of this paper was to present robust estimates of growth and poverty elasticities for information technology in Pakistan using annual data from 1980-2009. In particular, to estimate short-run elasticities, which are useful to policy makers, a statistically sound error-correction model was employed to model the underlying short-term dynamics, without losing any long-term information inherent in the technology system. The results indicate that increase in usage of ICT decreases poverty by almost 3% in the short-run. While in long-run, a positive relationship is established between ICT, economic growth and poverty. The results depict that ICT and economic growth is necessary but not a sufficient condition for poverty alleviation. There is a need of some more empirical tests in this respect. The error correction term significantly converge the model towards long-run equilibrium.

There is a need to design, test, and learn from innovative electronic media-based strategies, supported by information technology in strategies and ways of increasing participation of the poor in governance, to make use of market information, and increase their access to a variety of resources to address the basic issue of poverty reduction. Such analysis would hold implications for IT in the perspective of Pakistan poverty and alleviation policies in the future.

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