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Full Length Research Paper

Information technology, financial deepening and economic growth: Some evidence from a fast growing emerging economy

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We empirically assess the role of information technology and financial deepening in Qatar's fast growing economy. Our analysis follows the vector-error-correction modeling technique that is capable of exploring long-run relations and short-run causal dynamics. We further investigate the common permanent components of the cointegrating system to identify the main driving forces. Consistent with some theoretical priors, the results suggest that real economic growth in Qatar is robustly linked over the long-run to both financial deepening and information technology (defined alternatively). The results further indicate that IT is relatively more important than financial development for propelling long-run growth. However, we find financial development, rather than IT, to be more critical for enhancing economic growth over the short-run horizon.

Key words: Economic growth, financial deepening, information technology, VECM.

INTRODUCTION

Endowed with large oil reserves and huge natural gas reserves (second only to Russia), Qatar has one of the fastest growing economies in the Gulf region, and her future economic outlook remains upbeat supported by record high world prices of both oil and natural gas. Benefiting from government efforts to diversify the domestic economy and enlist alternative (non-energy) sources of national income, Qatar has experienced a remarkable growth record at least over the recent period 2000-2007 whereby its real non-oil economy has been growing by more than 10% annually (official data from the Central Bank of Qatar).

A careful inspection of data and germane economic and finance literature reveals the need to examine the possible role of two factors in the recent Qatar's growth experience; namely, financial deepening and information technology (IT). The hypothesis that financial deepening is a necessary pre-condition for economic growth rests on many premises [Levine, 1997; Levine and Zervos, 1998). Well-functioning financial institutions enhance overall economic efficiency, create and expand liquidity, mobilize savings, promote capital accumulation, transfer resources from traditional (non-growth) sectors to the more modern growth-inducing sectors, and also encourage a competent entrepreneur response in these modern sectors of the economy. Influenced by the pre-ponderance of such theoretical reasoning, along with repeated recommendations of key world organizations like the World Bank and the International Monetary Fund, the government of Qatar has recently paid a great deal of attention to expanding the breadth and depth of its financial market. Examples of recent financial developments in Qatar include facilitating the entry of new domestic and foreign banks, continuous deregulation of bank lending and deposit interest rates, rapid use of credit and debit cards, increasing use of payment technologies like ATM machines and electronic transfer of deposits, expanding internet banking services, e-banking, and mobile banking technology. In their recent

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study, Creane et al. (2003) introduce a multifaceted construct to rank the stages of financial developments in the Middle East and North Africa (MENA) region. They conclude that Qatar does exhibit one of the highest levels of financial development among MENA countries. On the other hand, the neoclassical growth theory of Solow (1956) suggests that exogenous technical innovation (e.g., IT) is an indispensable growth factor primarily because IT enhances operational efficiency and boosts aggregate labor productivity which are major forces behind high economic growth and rising living standards (Jalava and Pohjola, 2005). Not surprisingly, Qatar has recently expended enormous efforts attempting to improve the quantity and the quality of IT equipment and software, network computing and internet services (A recent example is the decision of the University of Qatar, the country's premier university, to fully automate its administrative operations starting in 2006 using Oracle E-business services).

The main purpose of this paper is to explore the contribution of financial deepening and information technology in the growth process of Qatar. Despite the enormous attention and significant national resources that Qatar has dedicated to improving its financial market and IT infrastructure, to our knowledge there has been no prior study to assess whether these two factors have indeed significantly contributed to growth to justify the current policy emphasis on them. While the underlying theory seems clear on the positive contribution of financial deepening and IT to growth, several researchers have raised some doubts on the ability of either financial deepening or IT to spearhead the growth process. For example, Ireland (1994) and Demetriades and Hussein (1996) argue that any evolution in financial markets is simply a passive response to a growing economy. As the real sector expands and grows (e.g., as result of accumulation of human capital or improvement in labor productivity), the expanding real sector would generate increased and new demands for financial services. This in turn would intensify pressures to establish larger and more sophisticated financial institutions to satisfy the new demand for their services. Similarly, the increasing pressure from a growing economy could result in improved information technology. Dewan and Kramer (2000) and Pohjola (2002) present results casting doubts on the role of information technology in the growth process, at least for developing economies. Moreover, Mosesov and Sahawneh (2005) contend that financial development has no significant growth impact in the case of the United Arab Emirates, a country with similar economic and financial makeup to that of Qatar. Furthermore, Hassan (2003) reports that IT exerts significantly negative effects on economic growth in his sample of many countries including Qatar.

If the above opposing thesis is the correct description of reality, then policy efforts and scarce resources devoted to promoting financial development and/or information technology would be premature and even wasteful. Moreover, the unnecessary emphasis on financial deepening and IT could also divert attention away from other, perhaps more, urgent policy options to spur economic growth such as labor training programs and human capital accumulation to improve productivity, tax reforms to induce investment, and export promotion schemes. The upshot of these counterarguments is that neither theory nor the evidence on the growth contribution of financial deepening and IT appear sufficiently definitive, highlighting the need to carefully assess the experience of Qatar.

METHODOLOGY AND DATA

Many prior empirical studies on the role of financial deepening and/or IT in the growth process are either primarily correlation-based (traditional regressions) or focus on short-run growth effects. However, both aspects of these studies are problematic. While the conventional view holds that financial deepening (and IT) is a necessary pre-condition for economic growth, it is also theoretically plausible to argue that evolutions in the financial market and IT infrastructure are simply a passive response to a growing economy (Ireland, 1994; Demeriades and Hussein, 1996). Thus, the issue is not whether financial deepening and IT are associated with economic growth; rather, the hypothesis under testing is whether economic growth is unidirectionally caused by the two factors. In addition, economic growth is inherently a slow and gradual process that requires a long time to materialize. Consequently, models that focus on cointegrating (long-run) relationships appear more suitable for analyzing determinants of growth.

To avoid both shortcomings of prior research, the approach we follow in this paper is based on the multivariate vector-error-correction model (VECM) which emphasizes the causal dynamics and long-run relations among the variables of the model. The VECM model is a linear representation of the joint stochastic process that generates the variables. Each of the variables in the model is considered endogenous, comprising two components: a linear function of the past realization of all variables in the system (including a variable's own lagged values), as well as an unpredictable innovation component. Sims (1982), Todd (1990) and others recommend the use of VECMs as a useful alternative to "structural" modeling.

Our first task is to check the stationarity of the time series to avoid biased and unreliable inferences (Diebold and Kilian, 1999). Therefore, we begin our analysis by subjecting the data to unit root testing using the Augmented Dickey-Fuller (ADF). We complement the ADF procedure by the Phillip-Perron (PP) test to ensure reliability of our inferences regarding the important issue of data stationarity. We select the proper lags in both tests by the Akaike Information Criterion (AIC).

Once we determine the degree of integration of each variable, we then turn our attention to checking if the variables as a group share one or more unit roots in which case they become cointegrated and possess a long-run relationship. Examining the extent to which the variables have a long-run relation is particularly important in our case since *a priori* we expect that the response of the macro economy to financial deepening and IT to be essentially slow and distributed over a prolonged period of time. To test for cointegration, we apply the Johansen-Juselius (1990, JJ) efficient approach. Gonzalo (1994) demonstrates the superiority of the JJ test over alternative testing procedures. To avoid possible small-sample biases, we adjust the Johansen-Juselius test statistics using the correction procedure suggested by Reimers (1992).

Under cointegration, we perform two further tasks. First, a finding of significant cointegration by itself does not provide any information on which of the variables in the vector is responsible for binding them together over the long-run. For example, does financial deepening or IT investment contribute more to maintaining a reliable long-run relation with real economic growth? To address this important issue, we study the driving force(s) behind the cointegrating vector using the Gonzalo and Granger (1995) test of the common long-memory components of the cointegrating system.

Second, we utilize any underlying cointegrating relationship to construct the VECM based on the Granger (1986) Representation Theorem. In our case, we have three alternative VECMs, depending on how IT is measured (real telecom investments, the number of personal computers in use, or the number of internet users). Each of these VECMs comprises three (ECMs) equations: an equation for real economic growth; an equation for financial development, and an equation for IT. Each equation includes the distributed lags of the endogenous variable's own lags, the lagged values of the other two endogenous variables, and the corresponding one lag of the error-correction term. Note that imposing common (equal) lags in VECM models can bias the results [Ahking and Miller (1985)]. Following prior research, we use the final prediction criterion (the FPE) to determine the proper lag profile for each variable and in each equation.

We further use the specific gravity criterion of Caines et al. (1981) to select the order of inclusion of the variables in the various equations. There is, of course, no assurance that the lag profile based on the FPE criterion in any given case is the only appropriate profile in the lag space, and it is also possible that the lag-length chosen may be data-specific (see Thornton and Batten, 1985). Further, the lag profiles determined within single-equation estimates may not continue to be appropriate for the VECM system of equations. To ensure reliability and robustness, we subject the FPE-lag structures to over- and under-fitting testing in the context of system estimations. We examine the statistical adequacy of the various equations in the VECMs particularly for residual autocorrelation, heteroskedacticity and structural instability using a battery of tests. We then pool the three ECMs in each VECM together and estimate them by Zellner's Seemingly Unrelated Regressions (SUR) method. This method is selected since the error terms of the three ECMs in each system are significantly related. Using the SUR to estimate the three equations as a set enhances statistical efficiency. In each equation of the VECMs, the statistical significance of the coefficients on the lagged values of the other independent variables gauges the importance of short-run Granger-causality, while the significance of the coefficient on the lagged error-correction term reflects long-run Granger causality [Darrat, 1998].

The sample is quarterly covering the period 1993:Q1- 2006:Q4, the longest span on which necessary data are available on all variables (56 observations). (Due to the unavailability of quarterly data for IT and GDP, we used a geometric interpolation technique to obtain the quarterly figures from annual data). The data come from different sources as follows: for various IT measures, the data are compiled from the World Telecommunication/ICT Indicators Database and from the World Information Technology and Services Alliance (WITSA). For real GDP and prices, the data come from the Statistical Division-National Accounts of the United Nations. For monetary aggregates, the data come from the *IFS, CD-ROM* of the IMF.

Our analysis focuses on three basic variables: Real economic growth, financial development and IT. Real economic growth (G) can be measured by the percentage changes in real GDP.

However, measuring financial development and IT is not as easy or as straightforward. As Levine (2003) notes, the empirical constructs commonly used to measure financial development do not directly reflect the channels through which financial development impact growth (e.g., reducing information and transaction costs, improving capital allocation and corporate governance, and mobilizing savings). Nevertheless, the literature suggests the usefulness of the inverse of the broad-money income velocity (the ratio of broad money stock to nominal GDP) as a measure of financial development. This measure (denoted here by F) is often called the monetization ratio and was initially proposed by McKinnon (1973) and used by King and Levine (1993). It reflects the relative size, or the depth, of the financial market. An increase in this measure indicates further expansion in the financial sector relative to the rest of the economy (We also experimented with the ratio of demand deposits to M1 proposed by Vogel and Buser (1976), but the results were significantly inferior to those obtained from the monetization proxy). As to measuring IT, we use three alternative measures: real investments in information technology (V), the number of personal computers in thousands (P), and internet users per 100 population (I). Except for financial development (F) which is initially in ratios, all other variables are introduced in their natural logarithms to smooth out the underlying variances of the estimations thus inducing homoskedastic errors. Furthermore, the use of natural logarithms directly converts the estimated coefficients into elasticity measures.

EMPIRICAL RESULTS

As mentioned earlier, our analysis begins with testing for unit roots in the data. Table 1 assembles the results from the ADF and PP testing procedures. As the results show, all variables appear non-stationary in levels and in first-differences. However, the variables proved stationary once expressed in second-differences.

We turn next to testing for cointegration among the variables of the model. We perform the JJ test of cointegration on three alternative vectors, depending on how IT is measured. The test results from the JJ test of cointegration are assembled in Table 2. These results strongly suggest that there is at least one non-zero cointegrating vector linking the variables together. This finding proves robust on several grounds. First both versions of the JJ test (the trace as well as the maximal Eigen value statistics) concur in confirming the presence of significant conitegration. Second, as mentioned earlier, the compu-ted JJ statistics are corrected for possible small sample biases. Third, while six lags seem appropriate in the underlying JJ tests, the results (available upon request) are insensitive to using higher or lower lag profiles. Fourth, in the case where IT is measured by real investment in IT, the JJ results reveal the presence several significant cointegrating vectors. Having more than one significant cointegrating vector implies additional strengths for the underlying long run relation suggesting that the equilibrium relation is robust in more than one direction (Dickey et al., 1991).

In summary, the empirical results lend strong support to the hypothesis that information technology (however defined) and financial development share a robust long-

Table 1. Unit root test results.

Variables	Levels		First Differences		Second Differences	
	ADF	PP	ADF	PP	ADF	PP
F	-0.85	-0.84	-1.95	-2.23	-3.14**	-8.15**
P	-2.74	-4.26**	-0.84	-2.44	-2.03	-9.03**
I	-1.78	-1.88	-2.34	-2.08	-2.89**	-7.57**
V	0.86	-0.35	-1.91	-2.61	-2.81	-8.05**
G	0.67	1.02	-1.74	-2.87	-2.63**	-9.30**

Notes: F denotes financial development; P is the first proxy of IT (the number of personal Computers in use); I is the second measure of IT (the number of internet users); V is the third measure of IT (real investments in telecom); and G denotes real economic growth. An * indicates rejection of the null hypothesis of non-stationary at the 10% level of significance, while an ** indicates rejection at the 5% level.

Table 2. Multivariate cointegration test results.

Trace test			Maximal Eigen value test	
Null hypothesis	Alternative hypothesis	Statistics	Alternative hypothesis	Statistics
		Cointegrating vector: DG, DF, DV		
r = 0	r 1	70.27**	r = 1	43.04**
r 1	r 2	27.23**	r = 2	19.1**
r 2	r 3	8.14	r = 3	8.14
		Cointegrating vector: DG, DF, DP		
r = 0	r 1	56.09**	r = 1	44.32*
r 1	r 2	11.78	r = 2	8.49
r 2	r 3	3.28	r = 3	3.28
		Cointegrating vector: DG, DF, DI		
r = 0	r 1	61.78**	r = 1	48.10**
r 1	r 2	13.67	r = 2	9.99
r 2	r 3	3.69	r = 3	3.69

Notes: See notes to Table 1 for definitions of the variables. An * indicates rejection of the null of no-cointegration at the 10% level of significance, while an * indicates rejection at the 5% level.

run relation with economic growth in Qatar. Therefore, failure to account for such pronounced cointegrating relations among these three variables, at least in the context of Qatar, would lead to serious biases and incorrect inferences.

We should note that the above results do not provide much guidance on which of the two proposed growth factors (IT or financial deepening) carries more weight in the long-run growth process. For that purpose, we turn next to the Gonzalo and Granger (1995) test that can identify the common permanent component driving the cointegrating system. Table 3 reports the associated likelihood ratio (chi-squared) statistics. These results clearly show that IT proved to be an indispensable ingredient for growth in Qatar over the long-run. Specifically, for the null hypothesis that IT is not a main force driving the long-run growth process, the likelihood-ratio test statistics are highly significant and better than the 1% percent level. A somewhat similar conclusion emerged for financial deepening except that in the system where IT is measured by the number of internet users (DLI), financial deepening fails to carry any significant weight in the cointegrating system [the likelihood-ratio = 0.76 which is far less than even the 10% critical value of 4.61 with 2 d.f. [d.f. = ($v - r$), where v is the number of variables in the system (=3) and r is the rank of the cointegrating vector (=1)]. Taken together, these results confirm the profound role of IT and financial development in promoting long-run growth in Qatar and the results also attest to the relative importance of IT over financial development as a catalyst of long-term growth. Since real economic growth, financial deepening and IT proved to

Table 3. Driving force test results.

Null hypothesis: The variable being tested is not a main driving force	LR Statistics
Cointegrating vector: DG, DF, DV	
DG	2.19
DF	12.23**
DV	5.89*
Cointegrating vector: DG, DF, DP	
DG	39.80**
DF	13.23**
DP	34.95**
Cointegrating vector: DG, DF, DI	
DG	15.29**
DF	0.76
DI	23.78**

Notes: See notes to Tables 1 and 2.

be strongly cointegrated, Granger (1986) suggests that there must be causality in at least one direction among the three variables. Therefore, we turn our attention in this final stage of our analysis to discussing these interactions in the context of VECMs. As mentioned earlier, in any given equation of the estimated VECM, the statistical significance of the error-correction term gauges the presence of long-run Granger-causality from all independent variables in that equation to the dependent variable, while the joint significance of distributed lagged-coefficients indicates short-run Granger-causality from the particular independent variable to the dependent variable.

We check the adequacy of the estimated equations in the alternative VECMs for the presence of significant autocorrelation by the Breusch-Godfrey test and the results suggest the absence of significant autocorrelation. Furthermore, the Glejser test evinces no problem with heteroskedasticity, and the Farley-Hinich test generally indicates that the estimated equations possess the desired property of structural stability (detailed test results are available from the authors upon request). Since each equation in the VECM was initially specified individually, it is possible that some equations could behave differently once placed in the system of equations. To ensure proper specifications, we test whether higher or lower lag profiles to that found in single estimations are required in the context of system estimations. These series of over- and under-fitting tests on each equation of the system suggest the need for only few minor modifications in the underlying lag-profiles and the final VECMs have been adjusted to reflect these changes.

Using the model-building procedures discussed above, the final VECMs are:

Measuring IT by real telecom investment (V):

$$\begin{bmatrix} DDG_t \\ DDF_t \\ DDV_t \end{bmatrix} = \begin{bmatrix} \beta_{11}^{6}(L) & \beta_{12}^{4}(L) & 0 \\ 0 & \beta_{22}^{8}(L) & 0 \\ 0 & \beta_{32}^{8}(L) & \beta_{33}^{[illegible]}(L) \end{bmatrix} \begin{bmatrix} DDG_t \\ DDF_t \\ DDV_t \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} EC_{t-1} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix}$$

Measuring IT by the number of personal computers in use (P):

$$\begin{bmatrix} DDG_t \\ DDF_t \\ DDP_t \end{bmatrix} = \begin{bmatrix} \mu_{11}^{6}(L) & \mu_{12}^{4}(L) & \mu_{13}^{4}(L) \\ 0 & \mu_{22}^{8}(L) & \mu_{23}^{5}(L) \\ \mu_{31}^{8}(L) & \mu_{32}^{1}(L) & \mu_{33}^{8}(L) \end{bmatrix} \begin{bmatrix} DDG_t \\ DDF_t \\ DDP_t \end{bmatrix} + \begin{bmatrix} \Phi_1 \\ \Phi_2 \\ \Phi_3 \end{bmatrix} + \begin{bmatrix} \psi_1 \\ \psi_2 \\ \psi_3 \end{bmatrix} EC_{t-1} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix}$$

Measuring IT by the number of internet users (I):

$$\begin{bmatrix} DDG_t \\ DDF_t \\ DDI_t \end{bmatrix} = \begin{bmatrix} \eta_{11}^{6}(L) & \eta_{12}^{4}(L) & \eta_{13}^{8}(L) \\ 0 & \eta_{22}^{8}(L) & \eta_{23}^{8}(L) \\ 0 & 0 & \eta_{33}^{8}(L) \end{bmatrix} \begin{bmatrix} DDG_t \\ DDF_t \\ DDI_t \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \end{bmatrix} + \begin{bmatrix} \Omega_1 \\ \Omega_2 \\ \Omega_3 \end{bmatrix} EC_{t-1} + \begin{bmatrix} e''_{1t} \\ e''_{2t} \\ e''_{3t} \end{bmatrix}$$

Where; $DDG_t = (1-L)^2 \log G_t$, and G is real GDP; $DDF_t = (1-L)^2 F_t$, and F is the measure of financial development (=M2/GDP); $DDV_t = (1-L)^2 \log V_t$, and V is real telecom investment; $DDP_t = (1-L)^2 \log P_t$, and P is the number of personal computers in use; $DDI_t = (1-L) \log I_t$, and I is the number of internet users; $_{ij}^{k}$ (L) in system A are the k^{th} lag coefficient on variable i in equation j; the μ’s and the ’s in systems B and C are interpreted similarly; the ’s, the ’s and the ’s are constant terms; the ’s, the ’s and the ’s are the coefficients of the error terms; and vectors e, e', and e'' are white-noise residuals. Table 4 reports the LR statis-tics for testing the implied Granger-causality hypotheses. We do not report here the individual parameter estimates from the various VECMs, but they are available upon request. However, Sims (1982) cautions that such para-meter estimates are difficult to interpret due to the reduced-form nature of the model.

Consistent with the earlier evidence from the JJ test, the estimated VECMs confirm the presence of robust long-run relations among real economic growth, financial deepening and IT (alternatively measured). This is because the coefficients of the EC terms in the VECMs are generally negative and statistically significant at the 5% level of significance or better. The statistical significance of the error-correction terms in the real GDP growth equations indicates that both financial deepening and IT exert significant long-run causal effects on real economic growth. This finding corroborates the important contribution of financial deepening and IT for promoting long-run growth in Qatar.

Besides these long-run effects, the estimated VECMs also reveal significant short-run causal relations among financial deepening, IT and growth. Across the three alternative VECMs, the results suggest that financial deepening exerts significant short-run causal effects on growth, while feedbacks from growth to financial deepening are unimportant. As to the short-run causal relation between IT and growth, the results are less clear. When IT is measured by real investment in telecom (system A), there seems to be no short-run causal rela-tion in either direction between IT and growth. However, measuring IT by the number of personal computers in use (system B), the results support a bidirectional short-run causal effects between the two variables, and when IT is measured instead by the number of internet users (system C); IT has a significant unidirectional short-run causal effects on growth. Thus, while the short-run effects of IT on growth appear somewhat frail and depend on the particular measure of IT used, financial deepening exerts robust short-run causal effects on growth without feedbacks across all models. Hence, contrary to Stern (1989) and Ireland (1994), financial deepening seems an important engine of growth in Qatar especially in the short-run.

Conclusion

We investigate whether financial deepening and infor-mation technology (IT) have played a significant role in promoting growth in Qatar. There is some evidence from theory and empirical research suggesting that both factors should contribute to economic growth. However, several skeptics remain unconvinced and an inquiry into the particular experience of Qatar seems warranted. In so doing, we use the cointegration and vector-error-correction modeling techniques to uncover long-run relations among financial deepening, IT and economic growth as well as examine their short-run causal dynamics.

Contrary to the conclusions of Hassan (2003) for Qatar, Mosesov and Sahawneh (2005) for the United Arab Emirates, and Raynal (2006) for Latin America, our empirical results for Qatar lend strong support to the theoretical contention that real economic growth is robustly linked, at least over the long-run, to both finan-cial deepening and information technology infrastructure. Our evidence of potent and positive growth contributions from both financial deepening and IT in Qatar is consistent with the empirical findings reported for many other countries by, for example, Darrat (1999), Levine (1999), Easterly and Levine (2001), Colecchia and Schreyer (2002), Yoo (2003), Ghirmay (2005), Jalava and Pohjola (2005), Braund et al. (2006), Atkinson and McKay (2007), Shamim (2007) and Hung (2009).

In addition, our results from testing the main common permanent component, due to Gonzalo and Granger (1995), show that both information technology and financial development represent key forces driving the long-run growth process, although the evidence seems more compelling for the relative role of IT over financial deepening in the growth process. Thus, it appears that improving IT infrastructure is essential before financial deepening can have its simulative long-run effects on growth in Qatar. These findings for long-run relations received strong confirmation from estimating alternative VECMs as the results from these models show significant long-run interrelations among economic growth, financial deepening and IT. The estimated VECMs also indicate

Table 4. Test results of implied Granger-causality hypotheses (VECM system estimations).

Null hypothesis	LR Statistics	D.F.
Measuring IT by real telecom investment		
DDG Equation		
$\beta_{11}^{6}(L) = 0$	34.37**	6
$\beta_{12}^{4}(L) = 0$	25.40**	4
$\lambda_1 = 0$	6.11**	1
DDF Equation		
$\beta_{22}^{8}(L) = 0$	14.74*	8
$\lambda_2 = 0$	1.35	1
DDV Equation		
$\beta_{32}^{8}(L) = 0$	19.57**	8
$\beta_{33}^{6}(L) = 0$	18.30**	6
$\lambda_3 = 0$	0.02	1
Measuring IT by numbers of personal computers		
DDG Equation		
$\mu_{11}^{6}(L) = 0$	84.01**	6
$\mu_{12}^{4}(L) = 0$	58.52**	4
	79.65**	4
$\psi_1 = 0$	10.10**	1
DDF Equation		
$\mu_{22}^{8}(L) = 0$	27.49**	8
$\mu_{23}^{5}(L) = 0$	37.26**	5
$\psi_2 = 0$	1.78	1
DDP Equation		
$\mu_{31}^{8}(L) = 0$	11.51**	8
$\mu_{32}^{1}(L) = 0$	0.01	1
$\mu_{33}^{8}(L) = 0$	21.31**	8
$\psi_3 = 0$	0.23	1
Measuring IT by numbers of internet users		
DDG Equation		
$\eta_{11}^{6}(L) = 0$	175.42**	6
$\eta_{12}^{4}(L) = 0$	79.69**	4
$\eta_{13}^{8}(L) = 0$	78.52**	8
$\Omega_1 = 0$	3.83**	1
DDF Equation		
$\eta_{22}^{8}(L) = 0$	35.81**	8
$\eta_{23}^{8}(L) = 0$	40.19**	8

Table 4. Contd.

$\Omega_2=0$	1.87	1
DDI Equation		
$\eta_{33}^{8}(L) = 0$	15.75**	8
$\Omega_3 = 0$	4.88**	1

that, unlike IT, financial deepening exerts robust unidirectional short-run causal effects on growth across all models. Therefore, it appears that financial deepening can be relied upon in Qatar to reap quick economic benefits. However, major investments in IT infrastructure are indispensable for promoting long-run growth in the country.

REFERENCE

Ahking FW, Miller SM (1985), "The Relationship between Government Deficits, Money Growth and Inflation," J. Macroecon. pp. 447-467.

Atkinson S, McKay A (2007)," Understanding the economic benefits of the Information Technology Revolution." Digital Prosperity, ITIF.

Braund P, Frauscher K, Schwittay A, Petkosky D (2006)," Information and Communications Technology for Economic Development." A Report on the Global E-Discussion, World Bank Institute.

Caines PE, Keng CW, Sethi SP (1981), "Causality Analysis and Multivariate Autoregressive Modeling with an Application to upper market Sales Analysis," J. Econ. Dyn. Control pp. 267-298.

Colecchia A, Schreyer P (2002)," The Contribution of Information Communication Tech to Economic Growth in Nine OECD Countries." OECD Econ. Stud. p.34.

Darrat AF (1998)," Tax and Spend, or Spend and Tax? An Inquiry into the Turkish Budgetary Process." Southern Econ. J. 64: 940-956.

Darrat AF (1999)," Are Financial Deepening and Economic Growth Causally Related? Another Look at the Evidence." Int. Econ. J.13: 19-35.

Demeriades PO, Hussein KA (1996), "Does Financial Development Cause Economic Growth? Time-Series Evidence from 16 Countries." J. Dev. Econ. pp. 387-411.

Dewan S, Kramer KL (2000), "Information Technology and Productivity: Evidence from Country-Level Data." Management Science 46: 548-562.

Diebold FX, Kilian L (1999), "Unit Root Tests Are Useful for Selecting Forecasting Models." NBER Working Paper No. 6928.

Easterly W, Levine R (2001)," It's Not Factor Accumulation: Stylized Facts and Growth Models." World Bank Econ. Rev. 15: 177- 219.

Ghirmay T (2005)," Financial Development and Economic Growth in Sub-Sahara African Countries: Evidence from Time Series Analysis." Afr. Dev. Rev. 16: 415-432.

Gonzalo J (1994)," Five Alternative Methods of Estimating Long-Run Equilibrium Relations." J Econometrics 60: 203-223

Gonzalo J, Granger C (1995). "Estimation of Common Long- Memory Components in Cointegrated Systems." J. Bus. Econ. Stat.13: 27-35.

Granger CWJ (1986)," Developments in the Study of Cointegrated Economic Variables." Oxf. Bull. Econ. Stat. 48: 213-228.

Hassan K (2003), "FDI, Information Technology and Economic Growth in the MENA Region." Paper Presented at the 10th Conference of the Economic Research Forum.

Hung F (2009)," Explaining the Non-Linear Effects of Financial Development on Economic Growth." J. Econ. 97: 41-65.

Ireland PN (1994), "Money and Growth: An Alternative Approach." American Economic Review, March, pp.47-65.

Jalava J, Pohjola M (2005)," ICT as a Source of Output and Productivity Growth in Finland." Helsinki Center of Economic Research, Discussion Paper No. 52.

Johansen S, Juselius K (1990)," A Maximum Likelihood Estimation and Inferences on Cointegration with Application to the Demand for Money." Oxf. Bull. Econ. Stat. 52: 169- 216.

King RG, Levine R (1993), "Finance and Growth: Schumpeter Might Be Right." Q. J. Econ. August, pp.717-738.

Levine R (1997), "Financial Development and Economic Growth: Views and Agenda." J. Econ. Lit. 35: 688-726.

Darra AF (1999). "Financial Development and Economic Growth: Views and Agenda." World Bank Policy Research Working Paper Number 1678.

Darra AF (2003). More on Finance and Growth: More Finance, More Growth." Federal Reserve Bank of St. Louis, , July/August, Review 85: 31-46.

Levine R, Zervos S (1998),"Stock Markets, Banks, and Growth." Am. Econ. Rev. 88: 537-558.

McKinnon R (1973). Money and Capital in Economic Development. Washington, D.C.: Brookings Institution.

Mosesov A, Sahawneh N (2005), "UAE Financial Development and Economic Growth." Skyline Bus. J. 1(2).

Pohjola M (2002), "The New Economy in Growth and Development." Oxf. Rev. Econ. Policy 18: 380-396.

Raynal LB (2006)," Is Financial deepening Really Beneficial for Latin American Countries?" Working Paper, University of Oklahoma.

Reimers HE (1992), "Comparisons of Tests for Multivariate Cointegration." Stat. Papers 33: 335-359.

Shamim F (2007)," The ICT Environment, Financial Sector and Economic Growth: A Cross-Country Analysis." J. Econ. Stud. 34: 352-370.

Sims CA (1982), "Policy Analysis with Econometric Models." Brookings Papers on Economic Activity, pp. 107-152.

Solow RM (1956), "A Contribution to the Theory of Economic Growth." Q. J. Econ. 70: 65-94.

Stern N (1989), "The Economics of Development: A Survey." Econ. J. pp. 597-685.

Thornton DL, Batten DS (1985)," Lag-Length Selection and Tests of Granger-Causality between Money and Income", J. Money, Credit Bank. pp. 164-178.

Todd RM (1990), "Vector Autoregression Evidence on Monetarism: Another Look at the Robustness Debate," Federal Reserve Bank of Minneapolis, Q. Rev. pp. 19-37.

Vogel R, Buser S (1976), "Inflation, Financial Repression, and Capital Formation in Latin America," in Money and Finance in Economic Growth and Development. Ed, R. McKinnon, New York: Marcel Dekker, Inc.

Yoo S (2003), "Does Information Technology Contribute to Economic Growth in Developing Countries? A Cross-Country Analysis." Appl. Econ. Lett. 10: 679–682.