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ISLAMIC COUNTRIES ECONOMIC GROWTH AND ICT DEVELOPMENT: *THE MALAYSIAN CASE*

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In this paper, we conduct an examination on the causality and relationship between information and communication technology (ICT) and economic growth in an Islamic country, namely Malaysia. The study period in this paper is divided into two: from 1960 - 1982, and from 1983 - 2004. This is to examine if the contribution of ICT investment varies in different sample periods. The causality result showed that for the period 1960 – 1982, economic growth led to growth in ICT investment in Malaysia. In the second period (1983 – 2004), reverse causality was observed (ICT investment led economic growth in Malaysia). Such phenomenon could be caused by the major economic structural change that happened during the second period, attributed largely to the various industrialization strategies and technology policies implemented in the country. In this period, ICT investment had a positive and significant impact on Malaysia's economic growth. In fact, ICT investment was the major source for the Malaysian economy experiencing increasing returns to scale in the second period. The positive economic benefits stemmed from ICT that Malaysia experienced may be a useful lesson for other Islamic economies.

1. INTRODUCTION

Over the last four decades, developments in information and communication technology (ICT) have transformed the global economic landscape. The benefits of ICT include the following: cheaper and higher quality of communication; easier access to information and wider

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market reach; reduction of corruption and red-tape; and closer collaboration among all economic agents in the economy.

Several empirical studies have shown that the benefits of ICT have powered the productivity and economic performance of developed nations over the last four decades. Lau and Tokutsu (1992) examined the relationship between ICT and economic growth in the US over the period 1960 to 1990 using the production function approach. They found that ICT had contributed to nearly half of the national output during the study period. Other key empirical studies showed similar results for the US include Oliner and Sichel, 2000; Jorgenson and Stiroh, 2000 and Stiroh, 2002.

Kraemer and Dedrick (1993) examined the impact of ICT to economic growth in eleven Asia Pacific countries for the period 1983 to 1990. The study found that there was a significant and positive relationship between ICT and economic growth. Niininen (1998) estimated the contribution of ICT to Finland's economic growth over the period 1983 to 1996 using the growth accounting framework. In this study, the author decomposed economic growth into capital, labour and multifactor productivity. The study also examined the impact of ICT (that is computer hardware, software and computer labour) on economic growth. The empirical results showed that ICT contributed significantly to the economic growth of Finland.

Daveri (2000) examined the contribution of ICT on economic growth in eleven OECD countries. Using the growth accounting framework, the author found that ICT contributed significantly to economic growth of most OECD countries, especially during the mid 1990s. Using the growth accounting framework, Oulton (2001) examined the contribution of ICT to economic growth in the UK over the year 1989 to 1998. The ICT capital in this study included computers, software, telecommunications equipments and semiconductors. The empirical result showed that ICT had significantly contributed to economic growth in the UK, especially from 1994 to 1998.

Colecchia and Schreyer (2002) estimated the contribution of ICT on output growth in nine OECD countries over the period of 1980 to 2000. The empirical result showed ICT contributed between 20 percent and 50 percent of the national output growth over the study period in most countries. This increased to 30 percent to 90 percent per annum in mid 1990s. Piatkowski (2003) investigated the impact of ICT on economic growth in Poland over the period 1995 to 2000 using the growth accounting framework. This study found that ICT investment had contributed nearly 9 percent of Poland's economic growth during the sample period. The study found that the increase in ICT investment from 1993 to 2001 period was due to declining prices in ICT products and services. A similar study by Mas and Quesada (2005) showed that ICT investment has enhanced economic performance of Spain from 1985 to 2002.

While the literature consists of studies examining the relationship between ICT and economic performance for developed countries, the number of similar studies for Islamic economies is limited. The primary objective of this study is to examine empirically the relationship between ICT investment and economic output in an Islamic country, namely Malaysia.

From 1982 onwards, major macroeconomic policies were put in place to transform Malaysia from an agrarian economy to more technology-intensive economy under the leadership of the former Prime Minister, Tun Dr. Mahathir Mohamad. In this study we will assess if these policy measures have transformed the architecture of the Malaysian economy and to what extent statistically. To study the structural changes in the Malaysian economy, the Auto-Regressive Distributed Lagged Model – ARDL model (Pesaran et al., 2001) was used to assess the relationship between ICT and real gross domestic product (RGDP) for the following periods: 1960-1982 and 1983-2004.

The ARDL model used in this study has two major advantages over traditional error correction models such as the Engle and Granger (1987), Johansen (1988) and Johansen & Juselius (1990). First, the Pesaran et al.'s framework allows for the explanatory variables to be either stationary and/or non-stationary (that is, series with order of integration zero or one). Second, the cointegration test called the bounds test proposed by Pesaran et al. (2001) is super-consistent. That is, it is robust for small sample studies such as the present study.

The rest of the paper is as follows. Section 2 provides a brief review of the Malaysian economy. Section 3 provides the discussion on the econometric methodology used in this study. Section 4 presents the empirical results. Section 5 provides the summary and concluding remarks.

2. ICT Development in Malaysia: An Overview

Malaysia attained independence in 1957 and in the 1960s the agriculture sector was the main contributor to the economy. Much of the socioeconomic development polices in 1960s and 1970s were catered towards developing basic infrastructure and rural development. After the racial riots in 1969, the New Economic Policy was formulated to eradicate poverty and eliminate racial segregation based on socioeconomic function and geography.

In June 1981 Dr. Mahathir Mohamad was appointed the fourth Prime Minister of Malaysia. Under his leadership 'Vision 2020' was formulated to help transform Malaysia into a knowledge-driven society. Various macroeconomic policies were put in place to achieve Vision 2020. Incentives were provided to foreign enterprises to set-up manufacturing plants and industries in Malaysia. By early 1990s, Malaysia became the leading producer of electrical and electronics components outside US and Japan.

Under Dr. Mahathir's leadership there was a major push to transform Malaysia into an industrial power house. The Second Industrial Master Plan was launched with ICT playing a major role in the transformation of the economy. Informatization of the economy was seen as a key step to becoming an industrial-based economy. The National Information Technology Agenda (NICTA) was formulated in 1996 with the following strategic objectives: development of people, infostructure and applications. NICTA was seen as important driver for the diffusion, adoption and integration of ICT in all sectors of the economy.

The Multimedia Super Corridor (MSC) was one of the major initiatives under NICTA. The MSC was envisaged to catapult the nation into an informatised society. The MSC initiative was the largest infrastructure project costing close to USD19 billion. The geographical area of the

MSC is 800 square kilometers, which include two new cities called Putrajaya and Cyberjaya. Putrajaya is the new administrative capital of Malaysia (‘a paperless’ government city) and Cyberjaya was the test-bed for new generation multimedia and ICT technologies. The MSC roll-out was planned in three phases. In the first phase (1995-2003) various fiscal and non-fiscal incentives were provided to attract leading foreign ICT enterprises into the country to develop new generation ICT products and services. Collaboration between these foreign ICT companies and local ICT firms were envisaged to enhance technology transfer between foreign and local enterprises. In the second phase (2003-2010), the MSC initiative was to expand to other major cities. In the third phase (2010-2020), the MSC environment is expected to expand across the nation.

To increase the quality of the ICT services in the country, the state owned telecommunication provider, Telekom Malaysia was privatized. The government also liberalised the mobile phone market and the Internet industry. There were five new entrants in the mid 1990s. This increased competition in the ICT sector, reducing prices and increasing the quality of the service. In the late 1990s and early 2000, ICT connectivity in rural communities was intensified. In 2000, 33 pilot community-based Internet centres were developed nationwide and of these twelve ICT community centers were in rural areas (EPU, 2001). Rural schools were connected to the Internet using Very Small Aperture Terminal (VSAT) and wireless loop technology.

Besides the ICT infrastructure investment, the Malaysian government also increased investment in education and training, especially in the ICT area. This is to ensure future Malaysians are ICT-savvy. To increase the manpower and innovation in the ICT area, in 1996, a university focused in ICT and multimedia called the Multimedia University was established in the MSC area (Cyberjaya).

In summary, the Malaysia economy over the last 42 years have undergone major structural changes – transforming from an agrarian based economy (1960-1982) to industrial & manufacturing power house (1983-2004). Much of the transformation was a result of government-driven policy initiatives. Large investments in ICT infrastructure, human capital and innovation were seen as vital for the nation to raise its competitiveness and catch-up with more developed countries.

In the next section, we will empirically examine if the ICT policies and strategies implemented from 1983 to 2004 have resulted in a structural shift in the Malaysian economy.

3. Methodology

To ascertain the relationship between ICT investment and economic development, we first have to determine the direction of causality between ICT investment and economic growth in Malaysia. In this paper, the direction of causality between ICT investment and economic output (real gross domestic product–RGDP) will be conducted using the Granger causality test. If ICT investment is a function of real GDP (RGDP), then the model will be specified as:

$$ICT_t = f\left(RGDP_t,\ NICT_t,\ L_t\right) + u_t \qquad (1)$$

where at period t, ICT_t is ICT investment; $RGDP_t$ is the real gross domestic product; $NICT_t$ is non-ICT investment, and L_t is labour employed in Malaysia. In model (1), the RGDP 'Granger-Cause' ICT ($RGDP \xrightarrow{GC} ICT$). In this case, the economic output of a country plays a key role in enhancing ICT development in the country.

On the other hand, suppose RGDP is a function of ICT investment, then the model is specified as follows:

$$RGDP_t = g\left(ICT_t,\ NICT_t,\ L_t\right) + v_t \qquad (2)$$

In model (2), *ICT* 'Granger-Cause' RGDP ($ICT \xrightarrow{GC} RGDP$). In this case, *ICT* investment plays a key role in economic output of the country. The causality test for $RGDP \xrightarrow{GC} ICT$ involves estimating the following VAR (Vector Autoregression) model:

$$ICT_t = \sum_{i=1}^{p} \xi_i ICT_{t-i} + \sum_{i=1}^{q} \zeta_i RGDP_{t-i} + \sum_{i=1}^{r} \lambda_i NICT_{t-i} + \sum_{i=1}^{s} \delta_i L_{t-i} + u_t \qquad (3)$$

and testing the following null hypothesis $H_O : \zeta_1 = ... = \zeta_q = 0$.

If we wish to test $ICT \xrightarrow{GC} RGDP$, then we estimate the following VAR model:

$$RGDP_t = \sum_{i=1}^{p} \gamma_i RGDP_{t-i} + \sum_{i=1}^{q} \theta_i ICT_{t-i} + \sum_{i=1}^{r} \tau_i NICT_{t-i} + \sum_{i=1}^{s} \eta_i L_{t-i} + v_t \quad (4)$$

and test the following null hypothesis $H_O : \theta_1 = ... = \theta_q = 0$.

Engle and Granger (1987) have argued that estimation of (1) and (2) using ordinary least square (OLS) may lead to spurious result if the variables in the models are non-stationary. The stationarity properties (unit roots) of the time series were investigated using the Phillip-Perron test (PP-test). If the variables are non-stationary, then the Auto-Regressive Distributed Lag (ARDL) framework (Pesaran et al. 2001) will be used to examine the relationship between ICT investment and economic growth. The ARDL(p, $\mathbf{q}$) version of (1) is as follows:

$$\Delta ICT_t = \alpha_0 + \alpha_1 t + \varphi ICT_{t-1} + \boldsymbol{\psi}\mathbf{x}_{t-1} + \sum_{j=1}^{p-1} \beta_{y,j} \Delta ICT_{t-j} + \sum_{j=1}^{q-1} \beta_{\mathbf{x},j} \Delta \mathbf{x}_{t-j} + \boldsymbol{\omega}\Delta \mathbf{x}_t + u_t \quad (5)$$

where, Δ is the first-difference operator, the matrix $\mathbf{x}_{t-j} = [RGDP_{t-j}, NICT_{t-j}, L_{t-j}]'$. The long-run coefficient is $-\frac{\boldsymbol{\psi}}{\varphi}$. The short-run information is given in the β's. On the other hand, the ARDL (p, $\mathbf{q}$) version of (2) is as follows:

$$\Delta RGDP_t = \alpha_0^* + \alpha_1^* t + \varphi^* RGDP_{t-1} + \boldsymbol{\psi}^* \mathbf{x}_{t-1}^* + \sum_{j=1}^{p-1} \beta_{y,j}^* \Delta RGDP_{t-j} + \sum_{j=1}^{q-1} \beta_{\mathbf{x},j}^* \Delta \mathbf{x}_{t-j}^* + \boldsymbol{\omega}^* \Delta \mathbf{x}_t^* + v_t \quad (6)$$

where $\mathbf{x}_{t-j}^* = [ICT_{t-j}, NICT_{t-j}, L_{t-j}]'$. The long-run coefficient is $-\frac{\boldsymbol{\psi}^*}{\varphi^*}$.

The short-run information is given in β^*'s. To determine the optimal lag length for model (5) and model (6), the Akaike Information Criterion (AIC) was used.

In order to test the existence of a long run relationship between the dependent and independent variables, the bounds test proposed in Pesaran et al. (2001) is used. The test is similar to the Wald-type test for coefficient test. In the case of the ARDL model in (5), the test will show no cointegration relationship under the null hypothesis $H_0 : \varphi = \boldsymbol{\psi} = \mathbf{0}$. In the case of ARDL model in (6), there is no cointegration relationship under the null hypothesis $H_0 : \varphi^* = \boldsymbol{\psi}^* = \mathbf{0}$.

The *F-test* has a non-standard distribution and the critical bounds (Upper and Lower bound values) for the test were taken from the tables given in Pesaran et al. (2001). If the computed *F* statistics was above the Upper Critical Bound, there is cointegration relationship between the variables in the model. If the computed F statistics is below the Lower Critical Bound, then there is no cointegration relationship. On the other hand, if the computed *F* statistics is between the Lower and Upper Critical Bound, then a conclusive inference cannot be made without examining the order of integration of each of the variables.

Once the optimal ARDL model is chosen, various diagnostic tests were conducted to ensure that the residuals of the models satisfy the standard regularity conditions. This involves the Lagrange Multiplier test for serial correlation, White's test for heteroskedastic, the Auto-regressive conditional heteroskedastic (ARCH-LM) test and the Jarque-Bera test for normality of the residuals. Finally, we test the model specification using the Ramsey RESET test.

To compute the ICT investment for the sample period, thirteen ICT based products were summed. The components of ICT were identified based on the classification of the Malaysian Standard Industrial Classification (MSIC) 2000 (refer to Table 1). The non-ICT investment data comprises of investment made into land & buildings, administration, health, economic services, education and transportation services. Data on labour employed and real GDP were obtained from the *DXEcon Database* (available at Monash University Malaysia). Meanwhile, data on ICT investment and non-ICT investment were compiled from various published government reports available from the Malaysian Department of Statistics. Except for the labour employed variable (denoted in million of workers), the other variables are denoted in Malaysian Ringgit (in millions) at current price.

In this study, we test if the data generation process if significantly different in the following periods 1960-1982 and 1983-2004. As mentioned in the earlier section, in the period 1960-1982, the Malaysian economy was dependent on the agriculture sector. From 1983 onwards, under the leadership of Prime Minister Dr. Mahathir, there were major policy initiatives to increase the diffusion of new technology, especially ICT in the Malaysian economy. Investment patterns in both the sample period are significantly different (refer to Figure 1). In this study, we are interested in assessing if the ICT investment patterns in the latter period have changed the underlying structure of the Malaysian economy (output).

Table 1: ICT Investment Products Classification MSIC 2000

Commodity Division (MSIC 2000 Classification)	**Industry/Product Description**
75	Office machinery and automatic data processing equipment.
76	Telecommunication, sound recording, reproducing equipment
751	Office machines
752	Automatic data processing machines
759	Parts and accessories for other automatic machines
761	Television receivers
762	Radio broadcast receivers
763	Gramophones, dictating machine, sound recorders
764	Telecommunication equipments and parts
771	Electrical power machinery and parts
772	Electrical apparatus, resistors and switchboards
773	Equipment for distributing electricity
774	Electro medical and radiological apparatus

Source: ICT Survey Report (2003), Department of Statistics Malaysia.

4. Empirical Results

In this section, we report the empirical results for the two sample periods (1960-1982 and 1983-2004).

4.1. Unit Root Test

Table 2 provides the results of the unit root test using the PP test. The result shows that *RGDP*, *ICT* and *NICT* are non-stationary, that is, integrated of order one *I*(1). Meanwhile, *L* is a stationary series.

Table 2: Philip-Perron Unit Root Test

Factor	**Level**	**1st Difference**	**Order of Integration**
RGDP	1.380	-5.912 *	*I* (1)
ICT	3.476	-4.047 *	*I* (1)
NICT	1.202	-3.328 **	*I* (1)
L	-2.105 *		*I* (0)

Notes: *, **, *** significant at 1 %, 5% and 10% significance level. All tests were conducted with trends and intercept.

4.2. Granger Causality Test

The Granger Causality test will be used to assess the direction of causality between ICT and economic growth in the two different sample periods (1960 – 1982 and 1983 – 2004). Table 3 shows the results for Granger causality for both sample periods. The result showed that in the sample period 1960 – 1982, RGDP Granger cause ICT at 10 percent significance level ($RGDP \xrightarrow{GC} ICT$). More precisely, growth in the Malaysian economy leads to higher ICT investment over the period 1960 – 1982. This result is not surprising because during this period the ICT infrastructures were basic and a large segment of the population did not have access to new technology. As such the ICT infrastructure was financed by the government.

In the sample period 1983 – 2004, ICT Granger causes RGDP at 10 percent significance level ($ICT \xrightarrow{GC} RGDP$). During this period, Malaysia's economic growth was significantly influenced by the growth in ICT investment. This is because there was greater diffusion of the new technology to a wider segment of the population and into the industrial structure of economy. Increased ICT infrastructure investment coupled with greater investment in human capital have lead to greater efficiency gains in the economy, resulting in higher economic growth.

Table 3: Granger Causality Test

	Period 1960 - 1982		**Period 1983 - 2004**	
H0	*F-Statistic*	*P-value*	*F-Statistic*	*P-value*
ICT does not *GC* GDP	1.02	0.44	4.33	0.06 ***
GDP does not *GC* ICT	3.21	0.06 ***	0.69	0.65

Note: *** Denotes statistically significant at 10 percent level.

4.3. The ARDL Estimation

The results from the Granger causality test showed ICT and RGDP as the dependent variables in the sample periods 1960–1982 and 1983-2004, respectively. In order to select the appropriate model, the ARDL[p, **q**] in (5) and (6) were estimated using the following lag lengths (p, **q)** = {1,2,and 3}. Lag length more than 3 were not used due to loss in the degree of freedom. The optimal lag structure for the model (5) and (6) were chosen based on AIC. The optimal model for (5) and (6) are ARDL [1,2,2,2] and ARDL [2,1,2,1], respectively. The estimated models for (5) and (6) are reported in Table 4. The diagnostic analysis for (5) and (6) showed that the residuals satisfied the standard regularity conditions. The Ramsey RESET test showed that the models in (5) and (6) were correctly specified.

4.4. Cointegration Test

Once the optimal ARDL models were ascertained, we examined whether the dependent factor (ICT for period 1960 – 1982 and RGDP for period 1983 – 20044) is cointegrated with the explanatory variables. The results are reported in Table 5. In both the sample periods the computed *F* statistics is higher than the Upper Critical Bound at the 1 percent significance level. This implies that there exists long run relationship between all the variables in both the periods.

Table 4: The ARDL Estimation and Diagnostic Analysis Results in both sample periods

Sample period 1960 – 1982: Dependent Variable: ICT			Sample period 1983 – 2004 Dependent Variable: RGDP		
Variables	**Coefficients**	**t-stats**	**Variables**	**Coefficients**	**t-stats**
Constant	402.995	1.714	Constant	283.483	1.234
Δ *ICT* (-1)	0.957	2.903 **	Δ *RGDP* (-1)	-0.572	-1.428
Δ *RGDP* (-1)	0.229	0.937	Δ *RGDP* (-2)	-0.756	-2.518 **
Δ *RGDP* (-2)	0.294	1.426	Δ *ICT* (-1)	0.002	0.006
Δ *NICT* (-1)	-1.803	-1.681	Δ *NICT* (-1)	0.73	3.032 **
Δ *NICT* (-2)	0.766	-1.288	Δ *NICT* (-2)	1.125	4.368 *
Δ *L* (-1)	33.051	1.854	Δ *L* (-1)	5.025	0.593
Δ *L* (-2)	24.005	1.583			
Diagnostic Analysis			**Diagnostic Analysis**		
R-Squared	0.859		R-Squared	0.901	
Residual sum of squares	0.029		Residual sum of squares	0.011	
Akaike Info. Criterion	21.066		Akaike Info. Criterion	24.924	
Durbin-Watson	2.607		Durbin-Watson	2.401	
F-statistic	3.070 [0.089]		F-statistic	5.016 [0.03]	
Jarque Bera	0.038 [0.981]		Jarque Bera	0.687 [0.709]	
LM test	5.282 [0.122]		LM test	1.522 [0.217]	
White's Heteroskedasticity	14.824 [0.537]		White's Heteroskedasticity	18.965 [0.27]	
ARCH	5.615 [0.690]		ARCH	5.525 [0.70]	
Ramsey RESET	2.367 [0.124]		Ramsey RESET	5.360 [0.121]	

Notes: * and ** are significant at the 1% and 5% significance level. The p-value is given in [ ].

Table 5: Bounds test cointegration results

Sample period 1960 – 1982	***Computed F-statistic: 7.04***	
Sample period 1983 – 2004	***Computed F-statistic: 10.33***	
Critical Values*	**Lower Bound**	**Upper Bound**
Critical Bound's value at 1%	5.17	6.36
Critical Bound's value at 5%	4.01	5.07
Critical Bound's value at 10%	3.47	4.45

4.5. Short and long-run elasticities

In this section, the short and long-term elasticities were computed (refer to Table 6) for both the sample periods. For sample period 1960–1982, the result showed that RGDP and NICT have positive impact on ICT in the short run and long run. However, the impact of RGDP and NICT was not statistically significant in the short run and long run. L was found to be positive and significant in the long run. A one percent increase in labour force will result in an increase of 1.47 percent increase in ICT. However, in the short run, L was found to be positive but not statistically significant.

Over the period 1983 - 2004, the result showed that the impact of ICT on RGDP was positive and significant at the 5 percent significance level. A one percent increase in ICT investment contributes to 0.54 percent of RGDP. In the short run L was found to have a negative impact on RGDP at the 10 percent significance level. This is not surprising because in this period Malaysia experienced a serious shortage of workers. Given, the economy was relatively small compared to other regional economies, Malaysia was not a cost-effective center for labour intensive-sectors. NICT was found to have a positive impact on ICT. However, the impact was not statistically significant. Summing the coefficients that are statistically significant in the model, we observe that in the short run, the Malaysian economy experienced decreasing returns to scale.

In the long run during the period 1983-2004, ICT was the only factor to have a positive and significant impact on RGDP (at the 10 percent significant level). A 1 percent increase in ICT investment contributes 1.74 percent in RGDP. Note that in the long run, ICT investment was the main factor for the economy experiencing increasing returns to scale. This imply that the diffusion of ICT into the economy from 1983-2004 was the main source of economic efficiency, hence increased real output (RGDP).

Table 6: Short and long term Elasticities

Sample period 1960 – 1982	**Dependent: ICT**	
Factors	**Short term**	**Long term**
RGDP	0.08	0.08
NICT	0.174	0.174
L	7.88	1.472**
Sample period 1983 – 2004	**Dependent: RGDP**	
Factors	**Short term**	**Long term**
ICT	0.5402 **	1.7367 ***
NICT	0.2727	-0.901
L	-0.6024 ***	-1.9365

Note: ** and *** denotes statistically significant at 5% and 10%, respectively.

5. SUMMARY AND CONCLUSIONS

The aim of this paper is to examine the relationship between ICT development and economic growth in Malaysia, one of the fastest growing Islamic countries in the world. The empirical analysis was conducted for two sample periods, namely 1960-1982 and 1983-2004. This was done to detect any structural change in the economy due to the ICT-driven policy implemented in the country.

The empirical analysis suggests that the Malaysian economy has undergone major structural change (increasing returns to scale) from 1983 to 2004 due to increased ICT investment. The policies and strategies under NICTA have contributed positively to the Malaysian economy. Lessons from the Malaysian case will be useful for other

Islamic countries in formulating ICT policies that will increase their socioeconomic status.

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