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THE IMPACT OF ICT IN MALAYSIA: A SIMULTANEOUS EQUATIONS APPROACH

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Abstract: This study measures the impact of ICT on Malaysia's aggregate output in the period 1965–2005. It closes a gap in existing literature by using the 3SLS technique on a country specific study. Telecommunication penetration rate is used as a proxy for ICT and analysed in both macro-economic and micro-economic perspectives. The findings of this study suggest that there is a causal relation between ICT and aggregate output in Malaysia and that the MSC and the privatisation policy of the telecommunication sector, are found to be indifferent to achieving expected economic growth in Malaysia.

Keywords: ICT; Malaysia; economic growth; SEM; simultaneous equations method.

INTRODUCTION

The remarkable progress in ICT1 witnessed in the past decade has made an increasingly profound impact on economic activity and the way people work, communicate, and spend time across countries around the world.

Over the last decade several methods have been used to analyse the impact of ICT on growth. Most studies analyse only one aspect of this nexus at a time, which is the macroeconomic aspect or the microeconomic aspect of the relationships.

Identifying the sources of economic growth appears to be an on-going research following the works of Solow (1956) and Romer (1986). Empirical studies on economic growth by De Long and Summers (1991, 1993) address the specific issue of equipment investment and its impact on economic growth. The development of ICT saw many studies augmenting the ICT-growth nexus model to include intangible variables and employing more sophisticated estimation techniques in the 1990s period. However, the results of the impact of ICT on growth still remain controversial. For example, Pohjola (2001) uses data covering the period 1980 to 1995 for 39 countries and employs the OLS method of estimation. He finds that the effect of ICT on growth is not significant, except for developed Organisation for Economic Cooperation and Development (OECD) countries where

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ICT has a significant positive effect on growth. Stiroh (2002) examined the impact of ICT on economic growth in the USA and concluded that there is evidence of ICT contribution to economic growth. Jeong and King (2001) examine the ICT-growth nexus using aggregate data covering the period 1980 to 1995 for Korea, and control for a number of ICT variables such as broad ICT investment, narrow ICT investment, and non-ICT investment. They obtain a positive and significant impact of ICT on growth. Beil et al. (2003) reported on the impact of telecommunication investment on economic growth for the USA based on the Granger-Sim Causality test, while Dedrick et al. (2003) provide relevant references to studies relating to Information Technology (IT) and economic performance.

Issues relating to the telecommunication sector are significant in these studies as telecommunication is acknowledged to be concomitant to the development of ICT. Roller and Waverman (2001) endogenised telecommunication investment in their macroeconomic model to determine the impact of this variable in a micro-economic environment based on the SEM. Their study on OECD countries indicates a significant impact of telecommunication investment on economic growth. Sridhar and Sridhar (2004) reported similar results in an almost identical study conducted on developing countries. The use of the Simultaneous Equations model has been applied to studies on income and population growth (Valdes, 1997), the determinants of economic growth (Broeck and Binder, 2005), the impact of FDI, IT and economic growth in the Middle East and North Africa (MENA) region (Hassan, 2005), and the preparedness of a country to exploit the capabilities of ICTs (Kauffman and Kumar, 2006).

The purpose of this study is to determine the impact of telecommunication investment, as a concomitant to ICT development, in a macro- and micro-economics perspective, taking into consideration the MSC and privatisation policy, which is unique to Malaysia compared to other developing countries. This paper examines the factors that contribute to the impact of ICT on economic growth in the OECD countries (Roller and Waverman, 2001) and selected developing countries (Sridhar and Sridhar, 2004) and compares them with Malaysia.

Changes in Malaysia's economic policy from import substitution to export oriented signify the ability to embrace technology and changes in order to achieve higher economic development. The privatisation policy in Malaysia, which started in the 1980s, indicates a change in the market structure for public goods. Telecommunication was the first economic sector that underwent this exercise. The development of the MSC in the mid 1990s indicates the government's vision of the significance of IT, specifically, ICT, and to promote this technology as its engine of growth.

This paper is organised as follows: Section 1 is an overview of ICT and economic growth in Malaysia; Section 2 describes the data set and a descriptive analysis of the data; Section 3 presents the methodology and estimation procedures; Section 4 reports the results; and Section 5 provides the conclusion.

ICT and economic growth in Malaysia

Malaysia's economic progress is an outcome of a basic policy framework and industrialisation strategies since independence. The history of Malaysia's Economic Policy framework and Industrial Development Strategies started in 1955 in the Report on the Economic Development of Malaya by the International Bank for Reconstruction and Development (IBRD), followed by the Federal Government Report of the Industrial Development Working Party in 1957, and the First Malaysia Plan 1966–1970.

The Malaysian economy was governed by the New Economic Policy (NEP) from 1971 to 1990 as contained in the First Outline Perspective Plan 1971–1990 (OPP1). The Second Outline Perspective Plan (OPP2), covering 1991 to 2000, was formulated based on the National Development Policy. Vision 2020 was launched in order to attain a fully developed and industrialised nation status. It is, essentially, a long-term vision (1991 to 2020) encompassing broad policy direction (Ramlan, 2001). Although the three documents vary in terms of time and focus, the main objective remains the same, that is, to establish a progressive, prosperous and united nation. These objectives imply achieving a dynamic and sustainable rate of economic growth.

Telecommunication and privatisation policy: a brief overview

Malaysian telecommunication was previously highly regulated, but since the inception of the NEP in the 1970s the Government of Malaysia has made an effort to liberalise the telecommunications industry. With the privatisation of the government telecommunications department in 1987 and the formation of the National Telecommunications Policy (NTP) in 1994 the market appears to have been fully opened (Table 1). The economic Master Plan for the telecommunications industry provides guidelines for competition, interconnection charges, tariff rates, network development, etc. At the end of 1995, all operators signed interconnection agreements with Telekom Malaysia to provide seamless communication without regard to carrier, yet most carriers have not signed agreements among themselves. Telekom Malaysia is Malaysia's largest telecommunications service provider.

The computer and software markets are fully deregulated, though restrictions do exist on participation in government bids, and equity restrictions on setting up manufacturing facilities.

The Multimedia Super Corridor (MSC): a brief overview

The MSC was conceptualised in 1996 to focus on multimedia and communications

Table 1 Market competitiveness – high/low comparative basis

Area of competition	Current status of competition
Domestic leased lines	Competition but Telekom Malaysia dominant
International leased lines	Competition but Telekom Malaysia dominant
Domestic VSAT	Monopoly
International VSAT	Fully competitive among Intelsat providers
Domestic telephony	Competition but Telekom Malaysia dominant
ISDN/Switched digital services	Competition but Telekom Malaysia dominant
International frame relay	Competition and foreign firms in market
Mobile data	Highly competitive
Mobile paging	Highly competitive

Source: Information Technology in Malaysia – privatisation and deregulation products, solutions, services, and research and development (Ramlan, 2001). The implementation of the MSC is divided into three phases from 1996 to 2020. In Phase 1 the objective is to develop the designated area. In Phase 2, the objective is to develop a web of similar corridors in Malaysia and to establish a global framework of cyber laws, with at least four intelligent cities to be linked to other global cities worldwide. In Phase 3, the objective is to enable the intelligent cities to evolve into one MSC. An International Cyber Court of Justice will be established in the MSC and 12 intelligent cities will be linked to the global information highway.[2]

The objectives of the MSC appear to align with the national economic plan of Vision 2020. This is reflected in the establishment of seven Flagship Applications. These applications are to initiate and create a multimedia utopia for producers and users of multimedia technology. The Flagship Applications are as follows:

- Electronic government
- Multipurpose card
- Smart schools
- Telehealth
- R&D clusters
- E-business
- Technopreneur development.

New legislation was introduced to support the development of the MSC and includes the following:

- Computer Crimes Act 1997
- Digital Signature Act 1997
- Telemedicine Act 1997
- Communication and Multimedia Act 1998
- In addition, the Copyright Act 1987 was amended to take account of recent developments in ICT.

The expansion of the MSC includes establishing MSC Cyber city and Cyber centre is reported to serve as the physical location and environment to catalyse and support the growth of ICT and ICT-enabled industries and, in tandem, extend the benefits of ICT to the local community. Under Phase One of the MSC, five Cyber cities have been developed in the country. They are Cyberjaya, Technology Park Malaysia, Universiti Putra Malaysia – Malaysian Technology Development Corporation (UPM-MTDC), Kuala Lumpur City Centre (KLCC) and KL Tower. Cyberjaya has been designated as the national ICT capital.[3] The MSC is also made up of companies which qualify for MSC-status, and are protected by the MSC's Bill of Guarantees.[4]

The development of the MSC appears to be significant in promoting sustainable economic growth as it involves the use of capital, labour and technology, which are fundamental to economic growth. The evolving economic policy, specifically the privatisation policy, appears to contribute to ICT development and economic growth in Malaysia. However, due to data restriction, the impact of these developments has yet to be ascertained. This is the caveat in this study.

DATA

This study is conducted for the period 1965 to 2005. The starting date is the conception of Malaysia as a sovereign country with the inclusion of the territories of Sabah and Sarawak in 1963, and the exclusion of the territory of Singapore in 1965. Data for this study were obtained from the World Development Indicators (World Development Indicators, 2004), World Bank, International Trade Statistics Yearbook (International Trade Statistics Yearbook, 2004), UN, and the Department of Statistics, Malaysia

The data required for the empirical implementation of the Simultaneous Equations Model are: real gross domestic product, real capital stock, total labour force (as a proxy for the stock of human capital), telephone mainlines waiting list per capita, telephone service price, imports of telecommunication equipment (as a proxy for real investment in telecommunication infrastructure), number of telephone mainlines per capita (as a proxy for the stock of telecommunications infrastructure), time trend, and dummy variables for the MSC project and the privatisation policy for Telecom Malaysia. In order to incorporate the effect of the MSC, a dummy variable is used to represent the establishment of the MSC; thus, MSC = 1 for the period 1996 to 2005 and MSC = 0 for the period 1966 to 1995. The privatisation of the telecommunication sector is reflected by a dummy variable in order to determine its significance on telecommunication investment on economic

Table 2 Data description

Variables		Mean	Maximum	Minimum	Standard deviation
GDP	Real gross domestic product in millions (constant US$)	1.03E+11	2.62E+11	2.08E+10	7.39E+10
K	Total fixed capital formation	23.86058	25.35186	22.15507	1.012045
HK	Total employment	62.74467	108.92	32.307	23.67097
Pop	Total population	1886868	26128000	9436	6742591
PR	Mainlines penetration rate	81.85775	202.9701	8	72.83725
SRpm	Service revenue per mainline	559.496	948.1266	299	172.3505
WLpc	Mainlines wait list	11.0632	12.20523	8.989694	0.929103
INV	Total imports of telecommunication equipment	1813.146	11524	14	2755.432
T	Time trend	21	41	1	11.97915
D1	Dummy variable for MSC; With MSC = 1, Without MSC = 0	0.243902	1.0	0.0	0.434769
D2	Dummy variable for privatisation policy; With policy = 1, Without policy = 0	0.463415	1.0	0.0	0.504854

For D1, MSC = 1 for the period 1996 to 2005, and MSC = 0 for the period 1965 to 1995.
For D2, Policy = 1 for the period 1986 to 2005, and Policy = 0 for the period 1965 to 1985.

growth; thus, the privatisation policy = 1 for the period 1987 to 2005, and the privatisation policy = 0 for the period 1966 to 1986. Table 2 shows the data description and the relevant statistics for the data.

Preliminary analysis indicates that the growth rates for per capita GDP have decreased significantly from 1966 to 2005. This might be due to several economic shocks throughout the period caused by commodity crisis and financial crisis. This result is reflective of the growth rate for telephone mainlines per 1000 inhabitants for the same period. Table 3 indicates that the acceleration rate for telephone mainlines has increased significantly for the period 1966 to 2005; almost double that of per capita GDP in the same period. This might result from the surge in telecommunication infrastructure development as the country shifted from an industrial to a technology oriented economy, to achieve sustainable economic growth.

SIMULTANEOUS EQUATIONS APPROACH

A simultaneous equation approach will be used based on Roller and Waverman (2001) and Sridhar and Sridhar (2004). The initial model was used to analyse a group of OECD countries and selected developing countries. This model is also significant for single country analysis. In the case of Malaysia, the development of the MSC and changes in economic policy relating to the telecommunication sector indicate a unique situation which warrants country specific analysis to determine the impact of telecommunication investment on economic growth. Deregulation of the telecommunication sector gave rise to the advent of new telecommunication companies providing products and services. Several studies relating to ICT and economic growth in Malaysia have been published. Huff (2001) analysed globalisation and the internet by comparing the Middle Eastern countries with Malaysia. Lee and Khatri (2003) analysed nine Asian countries based on the growth accounting method and concluded that the growth in Asia during the 1990s is mainly from capital deepening. Awang (2004) analysed the impact of human capital and technology in Malaysia's economic development, and Elsadig (2006) analysed ICT and economic growth in Malaysia's manufacturing sector, based on the growth accounting method.

The contribution of this study is to close the gap in existing studies using 3SLS to estimate the simultaneous equation functions, which is econometrically efficient compared

Table 3 Growth rates and average acceleration rate for per capita GDP, and telephone mainlines for Malaysia: 1966 to 2005

	1966	2005	Average acceleration rate
GDPpc	4.84	2.95	3.82
Mainlines per 1000 inhabitants	−3.61	−3.48	7.95

GDPpc is per capita Gross Domestic Products.

to General Method of Moments. This will determine the causality effect between ICT and aggregate output. This study will also close the gaps in Roller and Waverman (2001) and Sridhar and Sridhar (2004) in a country specific study for a developing country. Furthermore, this study also contributes to the existing literature on country specific studies.

In order to incorporate an ICT component into this approach and to improve the model for single country study, the improvised model is as follows:

- Aggregate production function:

  $GDP_t = e\,(K_t, HK_t, T_t, t)$

  where *GDP* is national aggregate economic activity, *K* is gross fixed capital, *HK* is stock of human capital, *T* is information and communication technology, and *t* is exogenous time trend.

- Demand for telecommunication infrastructure:

  $D_t = f\,(P_t, TP_t, X)$

  where *D* is demand for telecommunication infrastructure, *P* is income per capita, *TP* is price of telephone services, and *X* is other exogenous variables.

- Supply for telecommunication investment:

  $S_t = g\,(TP_t, WL_t, Z)$

  where *S* is telecommunication investment, *TP* is the price for telephone service, *WL* is waiting list per mainline, and *Z* is other exogenous variables.

- Telecommunication infrastructure production function:

  $dT_t = h\,(TI_t, P_t, W)$

  where *dT* is changes in ICT growth rate, *S* is telecommunication investment, *P* is income per capita, and *W* is other exogenous variables.

In order to examine the impact of the MSC and telecommunication policy, this paper introduces two models; Model 1 is estimated without the MSC and policy variables, and Model 2 is estimated with MSC and policy variables. The estimation procedures are as follows:

Model 1

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln K_t + \alpha_2 \ln HK_t + \alpha_3 \ln PEN_t + \alpha_4 \ln TI_t + \varepsilon_1 \quad (1)$$

where GDP is gross domestic products, *K* is capital, *HK* is total labour force, *PEN* is penetration rate for telephone mainline per 1000 people, which is proxy for ICT, and *TI* is imports of telecommunication equipments, which is proxy for stock of telecommunication investment, and *t* is time trend.

$$\ln(PEN + WL)_t = \beta_0 + \beta_1 \ln INC_t + \beta_2 \ln L_t + \beta_3 \ln TR_t + \varepsilon_2 \quad (2)$$

where *PEN* is penetration rate of telephone mainlines per 1000 people, *WL* is the waiting list for telephone lines applications, *INC* is income per capita, and *L* is total employed labour, and *TR* is revenue from telecommunication services.

$$\ln TI_t = \chi_0 + \chi_1 \ln PEN + \chi_2 TR_t + \chi_3 \ln WL_t + \varepsilon_3 \quad (3)$$

where *TI* is the demand for telecommunication investment, *TR* is revenue from telecommunication services, and *WL* is waiting list for telephone lines.

$$\Delta \ln PEN_t = \delta_0 + \delta_1 \ln TI_t + \delta_2 INC_t + \varepsilon_4 \quad (4)$$

where *PEN* is the change in the penetration rate of telephone mainlines per 1000 people, *TI* is telecommunication investment, and *INC* is income per capita.

Model 2

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln K_t + \alpha_2 \ln HK_t + \alpha_3 \ln PEN_t + \alpha_4 \ln TI_t + \varepsilon_1 \quad (1')$$

where *GDP* is gross domestic products, *K* is capital, *HK* is total employed labour force, *PEN* is penetration rate for telephone mainline per 1000 people, which is proxy for *ICT,* and *TI* is imports of telecommunications equipment, which is proxy for stock of telecommunication investment.

$$\ln(PEN+WL)_t = \beta_0 + \beta_1 \ln INC_t + \beta_2 \ln L_t + \beta_3 MSC + \beta_4 \ln TR_4 + \varepsilon_2 \quad (2')$$

where *PEN* is penetration rate of telephone mainlines per 1000 people, *WL* is the waiting list for telephone lines applications, *INC* is income per capita, *L* is total employed labour force, and *MSC* is a dummy variable representing the *MSC.*

$$\ln TI_t = \chi_0 + \chi_1 \ln PEN_t + \alpha_2 \ln WL_t + \alpha_3 TR_t + \alpha_4 PCY + \varepsilon_3 \quad (3')$$

where *TI* is the demand for telecommunication investment, *PEN* is penetration rate of telephone mainlines for per 1000 people, which is a proxy for *ICT*, *TR* is the revenue from telecommunication services, *WL* is the waiting list for telephone lines, and *PCY* is a dummy variable representing the telecommunication privatisation policy.

$$\Delta \ln PEN_t = \delta_0 + \delta_1 \ln TI_t + \delta_2 INC + \delta_3 MSC_t + \delta_4 PCY + \varepsilon_4 \quad (4')$$

where *PEN* is the change in the penetration rate of telephone mainlines per 1000 people, *TI* is telecommunication investment, *INC* is income per capita, *MSC* is a dummy variable representing the *MSC*, and *PCY* is a dummy variable representing the telecommunication privatisation policy.

RESULTS

Table 4 provides a summary of the results for the simultaneous equation functions. The estimation results for the production function for both models indicate that capital, labour, and telephone penetration rate have a positive impact on economic output, while imports of telecommunication equipment has a negative impact on output. This is not unusual for a production function as imports are expenditure, thus indicating an inverse relationship on aggregate output.

The demand function estimation results for Model 1 indicate that the income elasticity is 2.740, and price elasticity is –2.149. These results correspond with basic economic theory. In Model 2, the income elasticity is 3.855, and the price elasticity is –1.825. The *MSC* variable indicates that it is not significant, and suggests an adverse effect on demand for telecommunication services.

The results for the supply function indicate that the price elasticity is positive, 0.013, in Model 1 and negative, –1.571, in Model 2. This deviation from the economic theory suggests flaws in the telecommunication sector, which might require government intervention. The dummy variable, which reflects the privatisation policy, indicates a positive elasticity of 5.041 in Model 2. This is in line with results from Sridhar and Sridhar (2004) who commented on the significance of market structure in developing countries.

The telecommunication growth function estimates the relationship between telecommunication investment and penetration rate of telecommunication service. The elasticity

Table 4 Telecommunication and economic growth in Malaysia: simultaneous equations method using 3SLS: 1965 to 2005

Equations	Variables	Model 1	Model 2
Aggregate production function	Constant	8.409 (6.722)	9.771 (8.630)
	Capital	3.495 (8.534)	2.984 (7.691)
	Employed labour force	1.234 (21.886)	1.302 (20.035)
	Tel. mainline	0.181 (7.928)	0.171 (8.286)
	Tel. investment	–0.022 (–2.818)	–0.019 (–2.442)
	R-squared	0.99	0.99
Demand function	Constant	–13.932 (–6.691)	–3.255 (–0.470)
	Per capita gdp	2.740 (14.784)	3.855 (6.845)
	Employed labour force	–0.200 (–0.930)	–1.488 (–2.010)
	Revenue per mainline	–2.149 (–3.325)	–1.825 (–2.205)
	MSC	–	–0.168 (–1.363)
	R-squared	0.96	0.96
Supply function	Constant	9.313 (5.973)	–10.602 (–0.786)
	Waiting list	–4.330 (–4.935)	10.689 (1.246)
	Revenue per mainline	0.013 (0.051)	–1.571 (–1.618)
	Tel. mainline	1.835 (23.434)	–0.389 (–0.281)
	Policy	–	5.041 (1.685)
	R-squared	0.93	0.70
Telecommunication growth function	Constant	–13.566 (–18.253)	–19.130 (–10.353)
	Telecommunication investment	0.127 (8.269)	–0.220 (–1.867)
	Per capita income	1.955 (20.877)	2.819 (10.020)
	MSC	–	–0.376 (–1.916)
	Policy	–	0.886 (2.497)
	R-squared	0.96	0.95

Figures in parentheses are *t*-ratios. Model 1 is estimated without dummy variables, and Model 2 is estimated with dummy variables.

for telecommunication investment is 0.127 and –0.220 for model 1 and Model 2, respectively. Income elasticity is positive in both models at 1.955 and 2.819 for Models 1 and 2, respectively. All variables in both models are significant although some might not be essential to telecommunication growth.

CONCLUSION

The result of this study indicates that ICT is directly related to aggregate output in Malaysia. There is a causality effect between ICT and aggregate output. As output per capita and telecommunication investment affect telecommunication growth this, in turn, fosters the growth of output. As a producer and user of ICT products and services, both, telecommunication and manufacturing sectors complement each other in the contribution to aggregate output. However, this is not a restriction but an incentive for other economic sectors to convert to ICT as a means of enhancing productivity.

Income and price of telecommunication services have an impact on the demand and supply of telecommunication infrastructure. This suggests that the demand for telecommunication services will increase when income increases, and demand for telecommunication services will decrease when the price of telecommunication services increases. The supply function, on the other hand, indicates that supply of telecommunication services increases when the price of telecommunication services increases. This is consistent with the theory of demand and supply. The telecommunication growth rate function indicates that telecommunication investment has a positive impact on penetration growth rate, suggesting that an increase in telecommunication investment will increase telecommunication penetration growth rate. The MSC and privatisation policy variables are significant to the model but not essential to economic growth.

This paper concludes:

- there is causal relationship between ICT and aggregate output
- Malaysia as a producer and user of ICT products and services may benefit more from proper management of investment in telecommunication equipment and infrastructure
- the MSC and the telecommunication privatisation policy are favourable to telecommunication infrastructure and services providers but not to consumers of telecommunication services
- the role of the government and private sectors in ICT development should be re-evaluated for effectiveness and efficiency purposes
- further research is warranted to determine the spillover effects involving adaptation to ICT on economic growth.

BIOGRAPHY

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NOTES

[1] ICT is defined as Information Technology (IT) plus Telecommunication Equipment and Services. The IT, in turn, refers to a combined industry, which includes IT hardware (office machines, data processing equipment, and data communications equipment), IT software, and IT services (WITSA, 2000).

[2] www.msc.com.my

[3] www.msc.newsupdate.my

[4] There are ten items in the Bill of Guarantees. The MSC-status companies are divided into three categories; businesses, incubators, and higher education organizations.