Intl. J. Humanities (2010) Vol. 17 (1): (1-18)

Empirical Investigation of IT Diffusion Drivers in Developed & Developing Countries

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Received: 2/2/2009 Accepted: 17/11/2009

Abstract

This paper provides an empirically based insight into IT diffusion drivers in developed and developing countries. For this purpose, a new conceptual model with five main factors has been provided and tested using data from 34 developed and 209 developing countries in 2008. The results explore major role of factor "Trade Related Knowledge Spillovers: TRKS) in promoting IT diffusion in both developed and developing countries, and the importance of factor "Financial Resources" in accelerating IT diffusion in developing countries. The results can help IT policy-makers improve greater IT diffusion in a way that developing countries can take advantage of what already being enjoyed by the developed world.

Keywords: IT diffusion drivers, Developing countries, Developed counties, Trade related knowledge spillovers.

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[DOR: 20.1001.1.25382640.2010.17.1.6.2]

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1. Introduction

Many specialists believe that IT diffusion helps countries accelerate their development (Winston, 2009). Although many countries have experienced the benefits of IT diffusion (Kim et al. 2009), however, IT investments and diffusion had a positive and significant relationship with productivity growth at the macroeconomic level in developed countries, but not in developing countries (James, 2009). Hence, one of the key questions of researchers now becomes what factors influence IT diffusion in developed and developing countries. Moreover, it is rational if we expect that developing economies have different drivers for IT diffusion than their wealthier brethren. In spite of several studies on IT diffusion (such as Shih et al. 2008), only a few empirical studies have investigated the relationship between factors influencing the level of IT diffusion in developed and developing countries.

This paper aims at offering an empirically based insight into IT diffusion drivers. It will discuss how IT diffusion drivers may be correlated differently with IT diffusion levels in developed and developing countries. In other words, it explains whether there are differences in these factors between developed and developing countries. It is anticipated that result of this research can improve greater IT diffusion in a way that developing countries can take advantage of what already being enjoyed in the developed world and aid policy makers in their future strategies.

There are some major differences between the peresent study and that was conducted by Shih, Kenneth, Kraemer and Dedrick (2008). Although both researches study Resources to Make Investment (RMI), Structure of the Economy (SE), and the Quality of General Infrastructural (QGI) factors, however, their measures are almost different. Moreover, we examined the effects of two new factors named Trade Related Knowledge Spillovers (TRKS) and the Easiness of Doing Business and Competiveness (EDBC) as well.

The remainder of the paper is structured as follows. Next section of the paper briefly explains the literature. Section 3 introduces the theoretical framework, the conceptual and operational models, and the research hypotheses. The data and methodology described in section 4. The data analysis presented in section 5. Finally, the paper ends with a brief summary, conclusions and final remarks.

2. The Literature

2.1. Knowledge Spillovers and Trade Related Knowledge Spillovers

Today, there is a widespread belief among the specialist about the fundamental role of technological change and knowledge to the competitiveness and long-term growth of economies. In fact, knowledge creation is the engine for economic growth. The importance of knowledge and information has increased with

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the formation about the new economy and advances in Information and Communication Technologies (ICT).

There are different ways by which a firm, a country or a group of countries (such as developed or/and developing countries) can receive new technologies and information. One of the cheapest ways is called Knowledge Spillover (KS). The non-appropriable amount of knowledge generated by a firm's or country's innovation efforts is called KS.

KS among different economic units are one of the most intriguing aspects of technological innovations and are of great importance for public policy making. There are several papers that analyze the impact of technology and information on productivity. On the other hands, the literature shows that most of recent attentions have shifted from analysis of the productivity enhancing impact of technology to knowledge diffusion of new knowledge among people, especially to IT.

Coe, Helpman and Hoffmaister (1997) discuss that foreign knowledge can be transferred by several channels (such as by imports of intermediate and capital goods, cross-border learning of production methods, product design and organization, imitation of new products, development of technologies, and imitation of foreign technology). This argument let researcher to examine links between KS through trade and output or productivity growth. Accordingly, Coe et al. (1997) argue that developing countries can benefit from trading with industrial countries with a large stock of knowledge from their past R&D activities and investments and examine the extent to which developing countries benefit from R&D is performed in industrial countries. They study the relationship between countries total factor productivity with their investment in R&D, the degree of openness to trades that is measured by imports of machinery and equipments relative to Growth Domestic Productions (GDP), the quality of human forces that is measured by secondary school enrolment ratio, Foreign Direct Investment (FDI) as proxy of foreign R&D capital stock, and imports from industrial countries as % of GDP. Using 22 OECD countries and 77 developing countries data, they find that R&D spillovers from industrial countries are robust and countries with open economies gain most.

Lee (2006) using data from 16 OECD countries for the period 1981–2000 examines the significance of international KS through inward and outward FDI, intermediate goods imports, and disembodied direct channel that is approximated using a measure of technological proximity and patent citations between countries. They study the effectiveness of four different major channels for international KS that have been investigated separately in previous studies by relating the national productivity and these channels. They conclude that although international KS are significant and substantial,

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outward FDI and imports of intermediate goods are not conducive to international KS.

Falveya, Foster and Greenaway (2007) argue that although trade facilitate KS from developed to developing countries, the extent of KS benefits depend on domestic factors specifically relative backwardness and absorptive capacity. They relate growth rate of output per worker to growth of Trade Related Knowledge Spillovers (TRKS) and the ratio of investment to GDP, labor force growth, measure of schooling, the average ratio of imports plus exports to GDP (capturing other benefits of openness), and the measure of relative backwardness that is the proportional difference of initial GDP per worker in the recipient from that in the US. Their investigation on North–South TRKS show that absorptive capacity increases the benefits of knowledge spillovers, and that spillovers have least impact in countries closest to and farthest from the technological frontier.

2.2. IT Diffusion Drivers

Although various theoretical and empirical studies show that IT diffusion is correlated with the level of national wealth, other factors such as RMI, SE, QGI, EDBC and TRKS have been proved significant as well.

- *Resources for Making Investments (RMI).* Specialists believe that promoting IT diffusion level requires increasing investment in IT and investment, in turn, requires the availability of capital either from internal sources (such as equity markets and domestic loans and credits) or from external sources (such as FDI and/or foreign aid). For developed countries, equity markets and for most developing countries foreign aid as a substitute for scarce domestic capital and stimulate plays a significant role [Shih et al., 2008]. Then, we would expect that RMI positively correlate with IT diffusion.

- *Structure of the Economy (SE).* Various studies have noted that in financial services, the use of IT is much more pervasive and countries with larger financial services sectors have higher rates of diffusion in IT. Moreover, several earlier researches have found a significant positive association between the size of a country's services sector and IT investment and diffusion. Thus, one can expect the positive impact of the financial services sector on IT investment and diffusion to be more profound in developed countries than developing countries. [Kraemer and Dedrick, 1994; Caselli and Coleman, 2001; Robison and Crenshaw, 2002]. Accordingly, we would expect that there is a positive correlation between the sizes of a country's financial services sectors and IT diffusion level.

- *Quality of General Infrastructures (QGI).* Various studies show that effective adoption and usage of technologies such as IT requires strong infrastructures and good supplementary assets

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[Kraemer and Dedrick, 1994; Caselli and Coleman, 2001; Robison and Crenshaw, 2002; Shih et al. 2008, Al-mutawkkil, 2009; Hanafizadeh, 2009]. Falveya, Foster and Greenaway (2007) argue that trade facilitate KS from developed to developing countries, but the extent of KS benefits depend on domestic factors specifically relative backwardness and absorptive capacity. Accordingly, we would expect that there is a positive correlation between the quality of a country's infrastructures and absorptive capacity with IT diffusion level.

- *Easiness of Doing Business and Competition (EDBC).* Numerous studies have noted that the EDBC facilitates the technology adoption and diffusion. Several measures have been introduced to quantify the easiness of doing business and soundness of a competitive climate in a country. Ten measures that is widely used by international organizations (such as World Bank) are as follows:

1. Easiness of starting a business [Djankov et al., 2002]
2. Easiness of dealing with licenses [http://www.doingbusiness.org/Documents/Survey_Instruments/DL_2008_Eng.pdf],
3. Easiness of employing workers [Botero et al., 2004]
4. Easiness of registering property [http://www. doingbusiness.org/Documents/Survey.Instruments/RP_2008_Eng.pdf],
5. Easiness of getting credit [Djankov et al., 2007]
6. Easiness of protecting investors [Djankov et al., 2006
7. Paying taxes [Djankov et al., 2008]
8. Easiness of trading across borders [Djankov et al., 2007]
9. Enforcing contracts [Djankov et al., 2003]
10. Easiness of closing a business [Djankov et al., 2006; http://www.doingbusiness.org/MethodologySurveys]

Accordingly, we would expect that there is a positive correlation between the easiness of doing business and IT diffusion level.

- *Openness to External Influences and Trade Related Knowledge Spillovers (TRKS).* IT diffusion requires a broad range of technical and managerial knowledge. Researchers believe that foreign trade facilitates the diffusion of such knowledge across borders and FDI has a positive impact on technical progress in the host country [Coe et al., 1997; Barrell and Pain, 1997]. Greater external openness should lead to more rapid diffusion of technologies into a country because multinational firms bring with them business practices that rely intensively on IT and knowledge of how to use IT productively. Moreover, openness to trade forces a country to greater international competition, driving IT investment and diffusion as a tool of survival, and to adopt IT to meet the requirements of foreign suppliers or customers. Thus, we would expect that there is a positive correlation between the level of openness and the use of IT and that the impacts

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would be more significant for developing countries. [Coe et al., 1997; Barrell and Pain, 1997; Shih et al., 2008]

The TRKS literature implies that:

- KS is one of the cheapest ways of receiving knowledge
- R&D spillovers from industrial countries are robust
- Countries with open economies gain the most
- The effects of inward and outward FDI are not similar
- Absorptive capacity increases the benefits of knowledge spillovers
- KS have the least impact in countries closest to and farthest from the technological frontier.

Table 1 summarizes the literature on IT diffusion drivers.

Table 1 Summary of literature on IT diffusion drivers

Factors	**Related References**
Resources for technology investments	[Shih et al., 2008]
Structure of the economy	[Kraemer and Dedrick, 1994; Caselli and Coleman, 2001; Robison and Crenshaw, 2002]
Openness to external influences and trade knowledge spillovers	[Coe et al., 1997; Barrell and Pain, 1997; Shih et al., 2008]
Knowledge Spillovers and (KS) Trade Related Knowledge Spillovers (TRKS)	[Coe et al., 1997; Lee, 2006; Falveya et al., 2007; Deng, 2008; Shih et al., 2008]
Infrastructures	[Falveya et al., 2007; Kraemer and Dedrick, 1994; Caselli and Coleman, 2001; Robison and Crenshaw, 2002; Shih et al., 2008]
Easiness of Doing Business and Competition	[Djankov et al., 2002; Djankov et al., 2003; Botero et al., 2004; Djankov et al., 2007; Djankov et al., 2008] [[http://www.doingbusiness.org/Documents/Survey_Instruments/ RP_2008_Eng.pdf] [http://www.doingbusiness.org/Documents/Survey_Instruments/ DL_2008_Eng.pdf] [http://www.doingbusiness.org/MethodologySurveys

3. The Model and Research Hypotheses

Figure 1 shows the conceptual model of this research. In this model, IT diffusion relates to five main factors; TRKS, RMI, SE, EDBC, and QGI. Table 2 describes types of variables, IT diffusion drivers or the factors, and the measures that quantify each factors.

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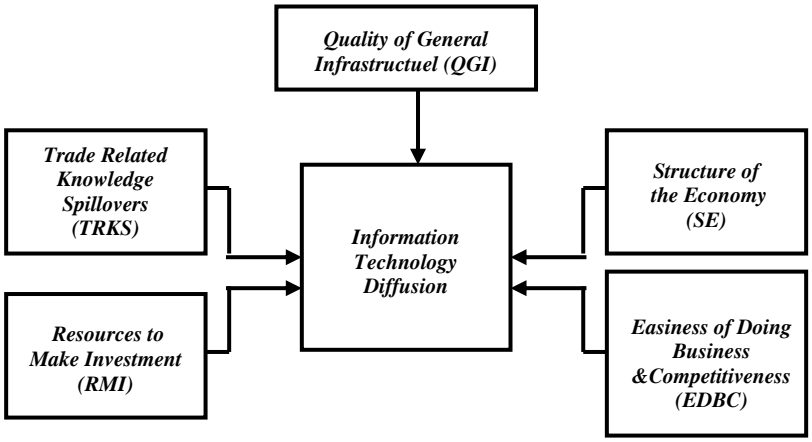

Figure 1 The Conceptual Model

Table 2 Type of variables, affective factors and measures

Type of Variables	Factors	Measures
Independent Variables	*Trade Related Knowledge Spillovers-TRKS*	1. Stock of direct foreign investment - abroad *(X11)* 2. Stock of direct foreign investment - at home *(X12)* 3. Foreign trade (Exports) *(X13)* 4. Foreign trade (Imports) *(X14)* 5. Foreign companies listed in country *(X15)*
	Resources to Make Investment-RMI	1. Reserves of foreign exchange and gold *(X21)* 2. Investment (gross fixed) *(X22)* 3. Public debt *(X23)* 4. Debt - external *(X24)* 5. Economic aid – donor *(X25)* 6. Economic aid – recipient *(X26)* 7. Market value of publicly traded shares *(X27)*
	Structure of the Economy-SE	1. Unemployment rate *(X31)* 2. Population below poverty line *(X32)* 3. Inflation rate (consumer prices) *(X33)* 4. Labor forces by occupation in services *(X34)* 5. Industrial production growth rate *(X35)* 6. GDP real growth rate *(X36)*
	Easiness of Doing Business & Competitiveness-EDBC	1. Ease of doing business *(X41)* 2. Starting a business *(X42)* 3. Dealing with licenses *(X43)* 4. Employing workers *(X44)* 5. Registering property *(X45)* 6. Getting credit *(X46)* 7. Protecting investors *(X47)* 8. Paying taxes *(X48)* 9. Trading across borders *(X49)* 10. Enforcing contracts *(X410)* 11. Closing a business *(X411)*
	Quality of General Infrastructural-QGI	1. Literacy *(X51)* 2. Age structure 15-64 years *(X52)* 3. Median age *(X53)* 4. HIV/AIDS *(X54)* 5. Infant mortality rate *(X55)* 6. Total fertility rate *(X56)* 7. Life expectancy at birth *(X57)*
	Wealth	1. GDP - per capita *(X58)*
Dependent Variable	*Information Technology Diffusion-ITD (Y)*	1. IT Diffusion indicator* *(Y)*

* We used mean rank of each country in terms of 5 measures. The measures that quantify IT Diffusion are internet hosts, internet users, telephones main lines in use, telephones- mobile cellular, and television - broadcast stations.

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This research investigates the following hypotheses:

H1: TRKS correlates with IT diffusion level

H11: Stock of direct foreign investment abroad correlates positively with IT diffusion level

H12: Stock of direct foreign investment at home correlates positively with IT diffusion level

H13: Exports correlate positively with IT diffusion level

H14: Imports correlate positively with IT diffusion level

H15: Number of foreign companies listed in an economy correlate positively with IT diffusion level

H2: RMI correlates with IT diffusion level

H21: Reserves of foreign exchange and gold correlate positively with IT diffusion level

H22: Investment (gross fixed) correlates positively with IT diffusion level

H23: Public debts correlate positively with IT diffusion level

H24: External debts correlate positively with IT diffusion level

H25: Economic aid as a donor correlates positively with IT diffusion level

H26: Economic aid as recipient correlates positively with IT diffusion level

H27: Market value of publicly traded shares correlates positively with IT diffusion level

H3: SE correlates with IT diffusion level

H31: Unemployment rate correlates negatively with IT diffusion level

H32: Population below poverty line correlates negatively with IT diffusion level

H33: Inflation rate or consumer prices correlate negatively with IT diffusion level

H34: Labor forces in services correlate positively with IT diffusion level

H35: Industrial production growth rate correlates positively with IT diffusion level

H36: GDP real growth rate correlates positively with IT diffusion level

H4: EDBC correlate with IT diffusion level

H41: Easiness of doing business rank correlates positively with IT diffusion level

H42: Easiness of starting a business correlates positively with IT diffusion level

H43: Easiness of dealing with licenses correlates positively with IT diffusion level

H44: Easiness of employing workers correlates positively with IT diffusion level

H45: Easiness of registering property correlates positively with IT diffusion level

H46: Easiness of getting credit correlates positively with IT diffusion level

H47: Easiness of protecting investors' correlates positively with IT diffusion level

H48: Easiness of paying taxes correlates positively with IT diffusion level

H49: Easiness of trading across borders correlate positively with IT diffusion level

H410: Easiness of enforcing contracts correlates positively with IT diffusion level

H411: Easiness of closing a business correlates positively with IT diffusion level

H5: QGI correlates to IT diffusion.

H51: The level of literacy correlates positively with IT diffusion level

H52: The population in age 15-64 years correlates positively with IT diffusion level

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H53: Median age correlates positively with IT diffusion level

H54: The population with HIV/AIDS correlates negatively with IT diffusion level

H55: Infant mortality rate correlates negatively with IT diffusion level

H56: Total fertility rate correlates negatively with IT diffusion level

H57: Life expectancy at birth correlates positively with IT diffusion level

H58: GDP per capita correlates positively with IT diffusion level

Our main idea is that the factors shaping IT diffusion in developing countries differ from those in developed ones. Figure 2 shows the operational model of this research.

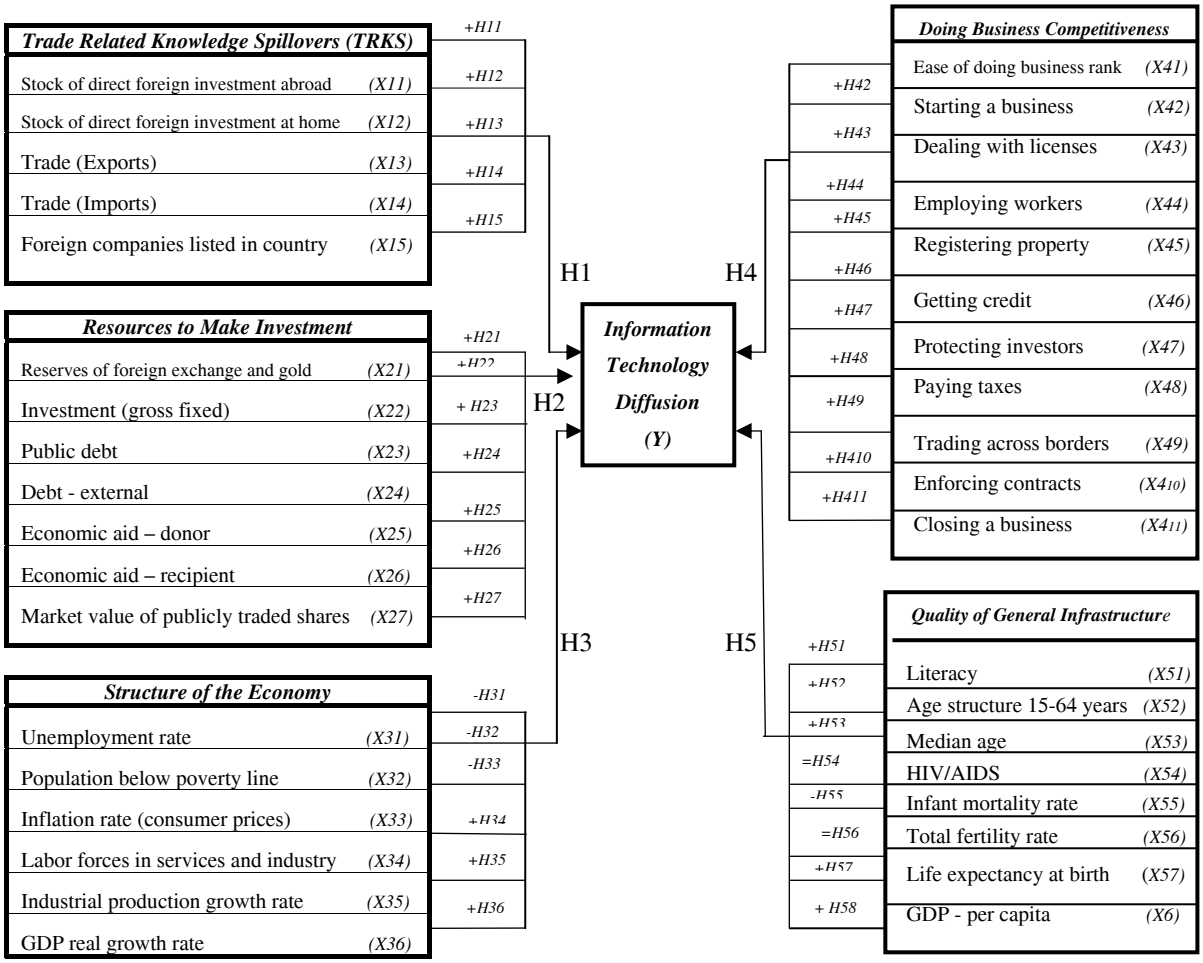

Figure 2 The Operational Model

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4. Data and Methodology

We developed model of IT drivers to identify which are correlated with IT diffusion in the entire sample of developed and developing countries. We used multiple measures to capture the factors hypothesized to correlate with the level of IT diffusion.

In order to test the hypotheses, we divide the sample into developed and developing countries. Developed countries usually have economic systems based on continuous, self-sustaining economic growth in the tertiary and quaternary sectors and high standards of living. Countries not fitting this definition may be referred to as developing countries. Accordingly, developed countries are Andorra, Australia, Austria, Belgium, Canada, China, Denmark, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Hong Kong, Iceland, Ireland, Territories not administered by the Palestinian authority, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, South Korea, Sweden, Switzerland, Taiwan, United Kingdom, and United States of America (n=34). Countries not including in this list referred to as developing countries (n=209).

The main part of data is based on a well-structured international database for year 2008 [http://www.theodora.com/wfb]. This website strategizes historical information in the Library of Congress, World Fact Books and some other major international databases such as UNCTAD, World Bank database, International Monetary Funds (IMF) database, as well as some other international geography, economic, social and cultural related organizations. In order to calculate rank of each country, in terms of number of foreign companies listed there, we used final World Exchange database for 2007 [http://www.world-exchange.org].

As mentioned earlier, we used multiple measures to capture the factors hypothesized to correlate with the level of IT diffusion. We used ranks of countries in terms of each measure of independent variable and in order to measure the dependent variable, IT diffusion level, we used mean rank of each country in terms of five different measures of ICT (internet hosts, internet users, telephones main lines in use, telephones- mobile cellular, and television-broadcast stations).

In order to analyze the data and compare the correlation coefficients in developed and developing counties, first we applied simple regression method. Since a systematic analysis of correlations requires incorporating all factors in a unique regression equation, we applied stepwise regression method as well. In order to adjust data for Skeweness, logarithm of data was applied. Finally, we have reported the results in terms of research hypotheses in developed and developing counties.

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5. Results of Data Analysis

5.1. Simple Regression Analysis

Table 3 shows the results of simple regression analysis for developed and developing countries. For developing countries most of research hypotheses (H1, H11, H12, H13, H14, H15, H2, H21, H22, H23, H24, H26, H27, H3, H34, H35, H36, H4, H41, H42, H43, H44, H45, H46, H47, H48, H49, H410, H411, H5, H51, H52, H53, H56, H57, H58) were significantly supported. In contrast, we could not find empirical evidences for H25, H31, H32, H33, H54, and H55. The results imply that all five factors (TRKS, RMI, SE, EDBC and QGI) significantly correlated with IT diffusion level in developing countries.

For developed countries, H1, H11, H12, H13, H14, H2, H21, H22, H23, H24, H25, H27, H31, H36, H4, H41, H42, H43, H44, H45, H46, H47, H49, H410, H411, H5, H51, H54 were significantly supported. In contrast, we could not find empirical evidences for H15, H26, H3, H32, H33, H34, H35, H48, H52, H53, H55, H56, H57 and H58. The results imply TRKS, RMI, EDBC and QGI significantly correlated with IT diffusion level in developed countries but not with SE.

5.2. Stepwise Regression Analysis

We have applied multivariate stepwise regression method for developed and developing countries. Tables 4 and 5 show results of data analysis for developed and developing countries. Table 4 implies that *X14, X48,* and *X43* have significant correlation with IT diffusion in developed countries. The regression equation that defines the relation between them is as following

(1)

$$Lny = 2.042897 + 0.62lnx14 - 0.411lnx48 + 0.300lnx43$$

By Removing the constant value from the equation *(1)* and using standard beta coefficients, the final equation becomes as Equation *(2).*

(2) $$Lny = 0.782lnx14 - 0.437lnx48 + 0.335lnx43$$

Table 5 shows *X13, X48, X6, X25, X27, X49, X42, X31* have correlation with IT diffusion and the regression equation that defines the relation is as Equation 3:

(3)

$$Lny = 10.729 + 0.897lnx13 - 0.084lnx48 - 0.109lnx6 - 3.141lnx25 + 0.156lnx27 - 0.111lnx49 + 0.069lnx42 - 0.037lnx31$$

By Removing the constant value from the equation *(3)* and using standard beta coefficients, the final equation will be as Equation *(4)*:

(4) $$Lny = 0.942lnx13 - 0.107lnx48 - 0.112lnx6 - 0.058lnx25 + 0.120lnx27 - 0.118lnx49 + 0.069lnx42 - 0.048lnx31$$

Equations *(2)* and *(4)* clearly show that there is a significant differences between developed and developing countries in terms of IT diffusion drivers.

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Table 3 Research hypotheses, simple regression equations for developed and developing countries

Hypotheses	Hypotheses Statements for Developed and Developing Countries	Simple Regression Equations For Developing Countries	Results	Simple Regression Equations For Developed Countries	Results
H1	*TRKS correlate with IT diffusion level*	Y= -13.725+1.486TRKS	Supported	Y= 15.653+1.073TRKS	Supported
H11	Stock of direct foreign investment abroad correlates positively with IT diffusion level	Y= -38.125+2.237X11	Supported	Y= 20.306+1.113X11	Supported
H12	Stock of direct foreign investment at home correlates positively with IT diffusion level	Y= -29.826+1.9667X12	Supported	Y= 16.203+1.128X12	Supported
H13	Exports correlate positively with IT diffusion level	Y= -21.176+0.70X13	Supported	Y= 21.086+0.706X13	Supported
H14	Imports correlate positively with IT diffusion level	Y= -24.915+0.675X14	Supported	Y= 21.711+0.630X14	Supported
H15	Number of foreign companies listed in economy correlates positively with IT diffusion level	Y= -35.848+6.101X15	Supported	No Linear or Non linear relation	Not Supported
H2	*RMI correlates with IT diffusion level*	Y= -14.568+2.152RMI	Supported	Y= -62.144+2.248RMI	Supported
H21	Reserves of foreign exchange and gold correlates positively with IT diffusion level	Y= 18.871+0.849X21	Supported	Y= 11.294+0.667X21	Supported
H22	Investment (gross fixed) correlates positively with IT diffusion level	Y= 52.527+0.790X22	Supported	Y= -8.241+0.872X22	Supported
H23	Public debts correlate positively with IT diffusion level	Y= 40.704+0.814X23	Supported	Y= 13.330+0.705X23	Supported
H24	External debts correlate positively with IT diffusion level	Y= 21.801+0.723X24	Supported	Y= 28.877+0.468X24	Supported
H25	Economic aid as a donor correlates positively with IT diffusion level	No Linear or Non linear relation	Not Supported	Y= 7.891+3.155X25	Supported
H26	Economic aid as recipient correlates positively with IT diffusion level	Y= 71.407+0.392X26	Supported	No Linear or Non linear relation	Not Supported
H27	Market value of publicly traded shares correlates positively with IT diffusion level	Y= -2.369+1.226X27	Supported	Y= 17.127+0.972X27	Supported
H3	*SE correlates with IT diffusion level*	Y= 18.468+3.145SE	Supported	No Linear or Non linear relation	Not Supported
H31	Unemployment rate correlates negatively with IT diffusion level	Y= 101.698+0.171X31	Not Supported	Y= -42.238+1.032X31	Supported
H32	Population below poverty line correlates negatively with IT diffusion level	Y= 92.979+0.344X32	Not Supported	No Linear or Non linear relation	Not Supported
H33	Inflation rate or consumer prices correlate negatively with IT diffusion level	Y= 75.333+0.681X33	Not Supported	No Linear or Non linear relation	Not Supported
H34	Labor forces in services and industry correlate positively with IT diffusion level	Y= 70.785+0.553X34	Supported	No Linear or Non linear relation	Not Supported
H35	Industrial production growth rate correlates positively with IT diffusion level	Y= 57.650+1.095X35	Supported	No linear but Quadratic and Cubic relation	Not Supported
H36	GDP real growth rate correlates positively with IT diffusion level	Y= 63.862+0.976X36	Supported	Y= 148.340-1.571X36	Not Supported
H4	*EDBC positively correlates with IT diffusion level*	Y= 33.265+0.661EDBC	Supported	Y= 24.240+0.475EDBC	Supported
H41	Easiness of doing business rank correlates positively with IT diffusion level	Y= 45.967+0.547X41	Supported	Y= 32.150+0.455X41	Supported
H42	Easiness of starting a business correlates positively with IT diffusion level	Y= 61.210+0.429X42	Supported	Y= 33.419+0.338X42	Supported
H43	Easiness of dealing with licenses correlates positively with IT diffusion level	Y= 80.905+0.272X43	Supported	Y= 23.883+0.466X43	Supported
H44	Easiness of employing workers correlates positively with IT diffusion level	Y= 81.610+0.272X44	Supported	Y= 30.265+0.252X44	Supported
H45	Easiness of registering property correlates positively with IT diffusion level	Y= 54.594+0.492X45	Supported	Y= 30.532+0.313X45	Supported
H46	Easiness of getting credit correlates positively with IT diffusion level	Y= 42.275+0.608X46	Supported	Y= 29.702+0.467X46	Supported
H47	Easiness of protecting investors' correlates positively with IT diffusion level	Y= 59.374+0.466X47	Supported	Y= 29.605+0.323X47	Supported
H48	Easiness of paying taxes correlates positively with IT diffusion level	Y= 87.884+0.219X48	Supported	No linear but Quadratic and Cubic relation	Not Supported
H49	Easiness of trading across borders correlates positively with IT diffusion level	Y= 48.906+0.524X49	Supported	Y= 30.462+0.471X49	Supported
H410	Easiness of enforcing contracts correlates positively with IT diffusion level	Y= 49.082+0.526X410	Supported	Y= 33.049+0.350X410	Supported
H411	Easiness of closing a business correlates positively with IT diffusion level	Y= 43.576+0.560X411	Supported	Y= 32.055+0.496X411	Supported
H5	*QGI correlates with IT diffusion level*	Y= 66.068+0.798QGI	Supported	Y= 3.205+2.832QGI	Supported
H51	The level of literacy correlates positively with IT diffusion level	Y= 89.849+0.347X51	Supported	Y= 35.854+0.850X51	Supported
H52	The population in age 15-64 years correlates positively with IT diffusion level	Y= 75.145+0.470X52	Supported	No Linear or Non linear relation	Not Supported
H53	Median age correlates positively with IT diffusion level	Y= 71.136+0.438X53	Supported	No linear power and S-curve relation	Not Supported
H54	The population with HIV/AIDS correlates negatively with IT diffusion level	Y= 66.161+0.595X54	Not Supported	Y= -26.219+1.030X54	Not Supported
H55	Infant mortality rate correlates negatively with IT diffusion level	Y= 101.902+0.114X55	Not Supported	No Linear or Non linear relation	Not Supported
H56	Total fertility rate correlates negatively with IT diffusion level	*	Not Supported	No Linear or Non linear relation	Not Supported
H57	Life expectancy at birth correlates positively with IT diffusion level	Y= 77.555+0.293X57	Supported	No Linear or Non linear relation	Not Supported
H58	GDP per capita correlates positively with IT diffusion level	Y= 73.194+0.393X58	Supported	No Linear or Non linear relation	Not Supported

*There is no linear relation between LnX56 and Ln Y, but we found Quadratic and Cubic relationships with following equations:

Quadratic $LnY = 151.432 + 1.082X56 - 0.006X56^2$ *Cubic* $LnY = 123.032 + 0.756X56 - 0.019X56^2 + 0.0000956^3$

*There is no linear relation between LnX35 and LnY, but we found Quadratic and Cubic relationships as following:

Power $LnY = \ln Y = \ln 10.030 + 0.457 \ln X53$ *or* $Y = 10.030X53^{0.457}$

S-curve: $\ln Y = 4.010 + (-4.509/X3)$ *(thegeneralequationisin* $y = a + (b1/x)$

Quadratic $LnY = 206.497 - 1.108X35 + 0.072X35^2$ *Cubic* $LnY = 105.504 + 1.684X35^2 - 0..LX35X56^3$

-There is no linear relation between LnX35 and LnY, but we found Quadratic and Cubic relationships as following:

Quadratic $LnY = 83.781 + 1.538X48 - 0.010X48^2$ *Cubic* $LnY = 69.085 - 0.421X48 + 0.007X48^2 + 0.0006X48^3$

--There is no linear relation between LnX53 and LnY, but we found Power and S-curve relationships as following:

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Table 4 ANOVA and coefficients of the model for developed countries

ANOVA							
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**	**Considerations**
1	Regression	16.498	1	16.498	66.298	0.000	Predictors: (Constant), *lnX14*
	Residual	6.469	33	0.249			*Dependent Variable:lnY*
	Total	22.965	34				
2	Regression	17.760	2	8.880	42.657	0.000	Predictors: (Constant), *lnX14, lnX48*
	Residual	5.204	32	0.208			*Dependent Variable:lnY*
	Total	22.965	34				
3	Regression	19.106	3	6.369	39.606	0.000	Predictors: (Constant), *lnX14, lnX48, lnX43*
	Residual	3.859	31	0.161			*Dependent Variable:lnY*
	Total	22.965	34				

Coefficients						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig**
		B	**Std. Error**	**Beta**		
1	Constant	1.386	0.289	0.848	4.796	0.000
	lnX14	0.672	0.083		8.142	0.000
2	Constant	2.172	0.414		5.244	0.000
	lnX14	0.695	0.76	0.876	9.134	0.000
	lnX48	-0.222	0.90	-0.236	-2.465	0.021
3	Constant	2.042	0.367		5.565	0.000
	nX14	0.620	0.072	0.782	8.654	0.000
	lnX48	-0.411	0.103	-0.437	-4.003	0.001
	lnX43	0.300	0.104	0.335	2.893	0.008

Table 5 ANOVA and coefficients of the model for developing countries

ANOVA							
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**	**Considerations**
1	Regression	90.779	1	90.779	1347.966	0.000	Predictors: (Constant), *lnX13*
	Residual	14.479	208	0.067			*Dependent Variable: lnY*
	Total	105.259	209				
2	Regression	92.525	2	46.263	777.486	0.000	Predictors: (Constant), *lnX13,lnX48*
	Residual	12.734	207	0.060			*Dependent Variable: lnY*
	Total	105.259	209				
3	Regression	93.694	3	31.231	575.208	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38*
	Residual	11.565	206	0.054			*Dependent Variable: lnY*
	Total	105.259	209				
4	Regression	94.091	4	23.523	446.535	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38, lnX25*
	Residual	11.168	205	0.053			*Dependent Variable: lnY*
	Total	105.259	209				
5	Regression	94.566	5	18.913	373.201	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38, lnX25, lnX27*
	Residual	10.693	204	0.051			*Dependent Variable: lnY*
	Total	105.529	209				
6	Regression	94.932	6	15.822	321.741	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38, lnX25, lnX27,lnX49*
	Residual	10.327	203	0.049			*Dependent Variable: lnY*
	Total	105.259	209				
7	Regression	95.208	7	13.601	282.845	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38, lnX25, lnX27 ,lnX49, lnX42*
	Residual	10.050	202	0.048			*Dependent Variable: lnY*
	Total	105.259	209				
8	Regression	95.447	8	11.931	252.935	0.000	Predictors: (Constant), *lnX14, lnX48, lnX38, lnX25, lnX27 ,lnX49, lnX42, lnX31*
	Residual	8.811	201	0.047			*Dependent Variable: lnY*
	Total	105.259	209				

Coefficients						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig**
		B	**Std. Error**	**Beta**		
1	Constant	10.729	3.731		2.875	0.004
	ln*X14*	0.897	0.035	0.942	25.668	0.000
	lnX48	-0.084	0.20	-0.107	-4.152	0.000
	lnX48	-0.109	0.022	-0.112	-4.880	0.000
	lnX25	-3.141	1.195	-0.058	-2.628	0.009
	lnX27	0.156	0.047	0.120	3.340	0.001
	lnX49	-0.111	0.031	-0.118	-3.601	0.000
	lnX42	0.069	0.028	0.069	2.452	0.015
	lnX31	-0.037	0.016	-0.048	-2.250	0.025

Tables 6 and 7 show results of the examination of the model for developing and developed countries conceptual model. They study the correlations between each factors (TRKS, RMI, SE, EDBC, QGI) and IT diffusion level in developed and developing countries. As shown in Table 6, the regression equation for developed countries can be defined as

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ln*Y=1.403+0.709TRKS.* By removing the constant value from the equation and using standard beta coefficients, the final equation will be as ln*Y=0.767TRKS.* It means that in developed countries, TRKS is the only variable that has significant correlation with IT diffusion.

Table 6: Model summary, ANOVA and coefficients of the model for developed countries

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Considerations
1	0.767	0.588	0.573	0.60299	Predictors: (Constant), *Trade Knowledge Spillovers* *Dependent Variable: lnY*

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig	Considerations
1	Regression	13.511	1	13.511	37.160	0.000	Predictors: (Constant), *Trade Knowledge Spillovers*
	Residual	9.454	33	0.364			*Dependent Variable: lnY*
	Total	22.965	34				

Coefficients

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
1 Constant	1.403	0.380	0.767	3.696	0.001
Trade Knowledge Spillovers	0.709	0.116		6.096	0.000

Excluded Variables

Model	Bea ln	t	Sig	Partial Correlation	Collinearity Statistics	Considerations
					Tolerance	
1 Resource to Make Investment	0.338	2.018	0.054	0.374	0.504	Predictors in the Model:
Structure of the Economy	-0.144	-1.148	0.262	-0.224	0.999	(Constant), *Trade Related*
Doing Business and Competitiveness	-0.105	-0.719	0.479	-0.142	0.758	*Knowledge Spillovers*
Quality of General Infrustructure	0.119	0.619	0.542	0.123	0.441	*Dependent Variable: lnY*

Table 7: Model summary, ANOVA and coefficients of the model for developing countries

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Considerations
1	0.879	0.772	0.771	0.33400	Predictors: (Constant), *Trade Knowledge Spillovers*
2	0.883	0.780	0.778	0.32862	Predictors: (Constant), *Trade Knowledge Spillovers, Recourses to Make Investment*
3	0.888	0.789	0.786	0.32259	Predictors: (Constant), *Trade Knowledge Spillovers, Recourses to Make Investment, Doing Business Competitiveness*
					Dependent Variable: lnY

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig	Considerations
1	Regression	81.274	1	81.274	728.549	0.000	Predictors: (Constant), *Trade Knowledge Spillovers*
	Residual	23.985	208	0.112			*Dependent Variable: lnY*
	Total	105.259	209				
2	Regression	82.149	2	41.074	380.347	0.000	Predictors: (Constant), *Trade Knowledge Spillovers, Recourses to Make Investment*
	Residual	23.110	207	0.108			*Dependent Variable: lnY*
	Total	105.259	209				
3	Regression	83.093	3	27.698	266.166	0.000	Predictors: (Constant), *Trade Knowledge Spillovers, Recourses to Make Investment,Doing Business Competitiveness*
	Residual	22.165	206	0.104			*Dependent Variable: lnY*
	Total	105.259	209				

Coefficients

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
1 Constant	-1.035	0.209		-4.946	0.000
Trade Knowledge Spillovers	1.286	0.048	0.879	26.992	0.000
2 Constant	-1.471	0.257		-5.732	0.000
Trade Knowledge Spillovers	1.084	0.085	0.741	2.784	0.000
Resources to Make Investment	0.296	0.104	0.165	2.845	0.005
3 Constant	-1.120	0.278		-4.034	0.000
Trade Knowledge Spillovers	1.160	0.087	0.793	13.338	0.000
Resources to Make Investment,	0.320	0.102	0.178	3.124	0.002
Doing Business Competitiveness	-0.167	0.055	-0.114	-3.013	0.003

Excluded Variables

Model	Bea ln	t	Sig	Partial Correlation	Collinearity Statistics	Considerations
					Tolerance	
1 Resource to Make Investment	0.165	2.845	0.005	0.191	0.305	Predictors in the Model: (Constant), *Trade Related*
Structure of the Economy	0.044	1.246	0.214	0.085	0.834	*Knowledge Spillovers*
Doing Business and Competitiveness	-0.105	-2.723	0.007	-0.183	0.695	*Dependent Variable: lnY*
Quality of General Infrastructures	0.066	-1.707	0.089	-0.116	0.711	
2 Structure of the Economy	0.008	0.197	0.844	0.014	0.713	Predictors in the Model: (Constant), *Trade Related*
Doing Business and Competitiveness	-0.114	-3.013	0.003	-0.202	0.690	*Knowledge Spillovers, Resource to Make*
Quality of General Infrastructures	-0.067	-1.782	0.076	-0.121	0.710	*Investment*
						Dependent Variable: lnY

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According Table 7, the regression equation for developing can be defined as following:

(5)

$$LnY = -1.057 + 1.125 lnTRKS + 0.364 lnRMI - 0.128 EDBC$$

By Removing the constant value from the equation *(5)* and using standard beta coefficients, the final equation will be as *(6)*.

(6)

$$LnY = 0.769 lnTRKS + 0.209 lnRMI - 0.108 EDBC$$

Equation (6) implies that TRKS, RMI and EDBC have significant correlations with IT diffusion in developing countries.

As a general conclusion, we find that among five factors, TRKS is the only factor that has positive and significant correlates with IT diffusion in both developed and developing countries, which support Coe et al. (1997), Lee (2006), Falveya et al. (2007), and Deng (2008). Moreover, we find that RMI plays a key role in developing countries.

6. Concluding Remarks

Many specialists believe that IT diffusion accelerates countries' development, but there is a few empirical researches on IT diffusion in developed and developing countries. This paper aims at offering an empirically based insight into IT diffusion drivers in developed and developing countries. It determines IT diffusion drivers in developed and developing countries. The empirical results imply that TRKS has significant positive correlation with IT diffusion in both developed and developing countries but in developing countries, TRKS, RMI and EDBC have significant correlations with IT diffusion. We found that because of the lack of financial resources in developed countries, RMI has a significant correlation with IT diffusion for developing countries but not for developed countries.

Generally speaking, the greater countries' openness and international trade through knowledge spillovers can develop IT diffusion in both developed and developing countries and that financial resources to make investment regards the other factor that helps developing countries accelerate their IT diffusion level.

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آزمون تجربی محرک‌های به‌کارگیری تکنولوژی اطلاعات در کشورهای توسعه یافته و در حال توسعه

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تاریخ دریافت: ۱۳۸۷/۱۱/۱۶ تاریخ پذیرش: ۱۳۸۸/۸/۲۶

این مقاله نتایج آزمون تجربی محرکهای به‌کارگیری تکنولوژی اطلاعات در کشورهای توسعه یافته و در حال توسعه را ارائه می نماید. جهت نیل به این هدف، ابتدا مدلی مفهومی متشکل از ۵ فاکتور اصلی ارائه گردیده است و سپس این مدل بر اساس داده های ۳٤ کشور توسعه یافته و ۲۱۱ کشور در حال توسعه در سال ۲۰۰۸ از جمله ایران مورد آزمون تجربی قرار گرفته است. نتایج بیانگر نقش مهم و برجسته و معنا دار فاکتور "انتقال دانش از طریق تجارت" یا فاکتور (Trade-Related Knowledge Spillover: TRKS) بر توسعه به‌کارگیری تکنولوژی اطلاعات در هر دو دسته از کشورهای توسعه یافته و در حال توسعه و همچنین نشانگر اهمیت معنادار فاکتور "منابع مالی جهت سرمایه گذاری" در شتاب بخشیدن به میزان به‌کارگیری تکنولوژی اطلاعات در کشورهای در حال توسعه می باشد. نتایج حاصله را می توان ابزاری جهت سیاست سازان در راستای توسعه به‌کارگیری تکنولوژی اطلاعات بشمار آورد به نحوی که کشورهای در حال توسعه را نیز قادر به بهره مندی از مزایایی نماید که کشورهای توسعه یافته تا کنون از آن بهره مند بوده اند.

واژگان کلیدی: محرک‌های به‌کارگیر تکنولوژی اطلاعات، کشورهای توسعه یافته، کشورهای در حال توسعه، انتقال دانش مبتنی بر تجارت

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