Journal of Economics and Development Vol.13, No.3, December 2011, pp. 37 - 57 ISSN 1859 0020

Technology - Development Investment and Firm Productivity in Developing Countries

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Abstract

This paper empirically investigates the impact of IT facilities and development investments on labor productivity to test the "productivity paradox", the interaction effects of firm-level contextual factors on this relationship, and the determinants of productivity for Vietnamese enterprises. In contrast to most of the existing literature that mainly consider patents or R&D in the relationship with firm productivity, this study investigates actual investments in two main areas: (i) Information technology facilities; (ii) development investment capital. The balanced panel dataset, which corresponds to a strong process of integration and globalization in Vietnam during the period 2001-2005, is investigated separately for the manufacturing and commercial-service sectors as well as the whole economy for comparison. Applying the fixed and random effects models, my findings imply that the "productivity paradox" does not occur for R&D for all firms, for computerization for manufacturing firms, for LAN connection and Internet situation for the commercial firms. In addition, the effects of IT facilities and development investments on labor productivity significantly depend on contextual moderating factors.

Keywords: productivity, "productivity paradox", IT investments, development investments, interaction effects, developing countries

JEL Classification: D24, E22, O14, O33, O47

1. Introduction

Increasing productivity plays an extremely important role in a firm's business strategy as well as economic growth. From a microeconomic perspective, an increase in productivity is deemed to improve profitability (Ghosal and Nair-Reichert, 2009). From a macroeconomic perspective, firms with higher productivity contribute more to GDP and improve economic growth. In advanced economies, the growth of productivity depends on technological innovation (Brynjolfsson and Hitt, 2003). Furthermore, information technology (IT) has its greatest impact on productivity (Malone et al., 1989; Gurbaxani and Whang, 1991; Bresnahan, 1997). This category of investments has impacts that are distinctly different from those of other categories. Not only can IT be used directly as an important production technology to improve significantly labor productivity, but it is also employed as an efficient technology for coordination to improve information-processing capability (Malone et al. 1989; Dedrick et al., 2003; Kobelsky et al., 2008). However, there is a controversy of the relationship between IT and productivity, which is of interest not only for businessmen but also policy makers.

In 1993, Brynjolfsson introduced the "productivity paradox" based on the evidence of "the sharp drop in productivity" that "roughly coincided with the rapid increase in the use of IT" in the US economy[1]. A great number of researchers found no relationship between IT and productivity (Loveman, 1994; Strassmann, 1997; Menon and Lee, 2000; Hu and Quan, 2005). However, mixed results are also found in many papers (Weill, 1992; Mahmood and Mann, 1993; Hitt and Brynjolfsson, 1996; Prattipati and Mensah, 1997; Devaraj and Kohli, 2000; Osei-Bryson and Ko, 2004; Sriram and Stump, 2004). Furthermore, technological innovation has recently been considered an accelerator for firm productivity by numerous other studies (Brynjolfsson and Hitt, 1995; Menon and Lee, 2000; Kudyba and Diwan, 2002a, 2002b; Kudyba and Vitaliano, 2003; Hu and Quan, 2005; Lee and Kim, 2006). While most of these studies focus on the case of developed countries, few papers investigate the case of developing countries, and most of those have presented mixed findings (Tam, 1998; Teo and Wong, 1998; Huang et al., 2006). Therefore, there is a recent call for further investigations of the "productivity paradox" for the case of developing countries.

Vietnam offers an appropriate laboratory among developing countries to investigate the "productivity paradox" and examine determinants of firm productivity. As a typical developing country in Asia, Vietnam has implemented an economic transition from the centrally planned economy to the market-oriented one. During this period, Vietnam has experienced tremendous changes in economic structure which have enhanced the growth of enterprises (Baughn et al., 2004), and international integration, such as joining the WTO in 2006. While Asia has recently become one of the world's three major economic centers, Vietnam has been considered one of the most prosperous and successful developing countries in Asia, with the growth rate of real GDP by 7.4% p.a. over the 1990s (Oostendorp et al., 2009), and by 7.6% p.a. during the period 2000-2007 (GSO, 2009). Recently, many domestic enterprises have actively accelerated the application of technology, investment in research and development, computerized business and production processes, renovate equipment and construction, and improve labor skills and qualifications. As the result, labor productivity growth in Vietnam has been so

outstanding that it was higher than other ASEAN countries during the period 2000-2008[2]. However, labour productivity in absolute terms is still low, even ranking second lowest among ASEAN countries in 2008, thus making it "one of the biggest challenges in the labour market in Viet Nam" [3].

Therefore, this paper aims to test the "productivity paradox", investigates determinants of firm productivity, and evaluates interaction effects of firm-level contextual factors on the relationship between IT facilities/development investments and firm productivity for the case of firms in a developing country, namely Vietnam. The study focuses on: (i) whether the "productivity paradox" exists; (ii) whether there are interaction effects of firm-level contextual factors on the relationship between IT facilities/development investments and productivity; (iii) whether this relationship is consistent among firms from different sectors.

The paper presents several contributions. In contrast to most of the existing literature that mainly consider patents or R&D in the relationship with firm productivity[4], the study investigates actual investments in two main areas: (i) Information technology facilities, including computer, internet access, and LAN connection; (ii) development investments, classified as investment portfolios, including investments for equipment and machinery; construction; and research and development. In addition, the study attempts to bridge the gap of the recent research on the mechanism by which IT investments pay off in higher productivity (Dedrick et al., 2003). The study explores contextual variables to identify this mechanism. Moreover, the employed data covers multi-sector and multi-size, which will help to close the gap in recent research that mainly focuses on single sectors and large firms (Dedrick et al., 2003). Furthermore, the data covers the period 2001-2005, an episode of strong integration and globalization processes in Vietnam. In addition, the paper employs fixed and random effects models to take into account the individual and time effects.

The rest of the paper is organized as follows. Section 2 is devoted to an overview of the literature and research hypotheses. The next section briefly describes the methodology employed including model, variables, and data. Section 4 presents the empirical results and analysis. The final section concludes and points out some policy implications.

2. Literature review and research hypotheses

In broad definition, IT investments include "investments in both computers and telecommunications and in related hardware, software, and services"[5]. IT investments are distinct from other genres of investments in their dual roles in a firm, that is, on one hand, similar to other kinds of capital, IT investments can directly support productivity in the role of a production technology (Dedrick et al., 2003). On the other hand, IT investments have their distinct impact in the role as an efficient technology for coordination (Malone et al., 1989; Dedrick et al., 2003; Kobelsky et al., 2008).

However, based on the evidence of "the sharp drop in productivity" that "roughly coincided with the rapid increase in the use of IT"[6] in the US, Brynjolfsson introduced the "productivity paradox" in 1993. Based on main findings, the literature on this issue could be divided into two stages[7]. The first part of research, from the mid 1980s to the mid 1990s, has findings consistent with the "productivity paradox", i.e. mainly negative or insignificant impacts of IT investments on productivity. The second one gradually refutes this paradox by presenting positive effects of IT investments

on productivity, from the mid 1990s till now.

In the first period, most papers found no positive and significant effect of IT investments on productivity at the firm or industrial levels or the whole economy (Roach, 1987, 1989; Strassmann, 1990). In 1992, for instance, Weill found no relationship between the investments in informational and strategic information system (IS) and business productivity in valve manufacturing firms. Similarly, Loveman (1994) investigated the benefits generated by IT investments in manufacturing firms between 1978 and 1984 and did not find any evidence of a positive association of IT investments with firm output.

Later empirical studies provide strong evidence of a positive correlation between IT investments and firm productivity. Brynjolfsson and Hitt (1995, 1996), and Lichtenberg (1995) employed production-function estimates and indicated that output elasticity for computers significantly exceeded its capital cost. Furthermore, Hu and Plant (2001) showed that IT investments in the preceding years increased firm productivity in subsequent years. Similarly, Brynjolfsson and Hitt (2003) concluded that computerization improved productivity and output growth. Ko et al. (2008) employed MARS techniques, and found that IT stock was the most crucial determinant of productivity. In addition, Lee and Kim (2006) concluded that IT investments had a positive impact on a firm's financial performance. In 2008, Kobelsky et al. studied IT spending from 1992–1997 to examine causality between IT investments and the earning volatility in the future. He found that this causality was highly contingent upon some firm level contextual factors, including sales growth, unrelated diversification, and size. Ghosal and Nair-Reichert, (2009) evaluated the role of investments in innovation and modernization on firm productivity. They concluded that firms that invested more in modernization achieved higher productivity; and investment transactions in digital monitoring and information technology devices particularly improved productivity.

An explanation for those contradictory findings in the two periods may result from IT investments' dual role (Dedrick et al., 2003). IT investments can enhance the capability of processing information, enabling firms to respond more quickly and efficiently to contextual uncertainty, and reducing volatility in productivity, however, IT investments have a significant risk of implementation, increasing the volatility (Kobelsky et al., 2008). Therefore, how the effect of IT investments on productivity changes after controlling contextual moderating effects[8] is one of the central questions of the recent productivity study. Besides, most studies only focus on developed countries, on the impacts of R&D and patents, and apply a simple method like OLS regression to examine the "productivity paradox". Another common shortcoming of most studies is that they are not often confined to the reform era, thereby considerably delimiting the empirical appeal of reform (Ghosh, 2009). Especially, no research has hitherto provided an analysis with comprehensive contextual variables at the firm level that would allow us to understand the mechanism by which firms can benefit from IT investments. Thus, recent studies attempt to cover those issues via examining below hypotheses:

Hypothesis 1: The "productivity paradox" does not occur, that is, IT facilities and development investments have positive effects on firm productivity.

Hypothesis 2: Favorable firm attributes and globalization factors improve productivity and the relationship between IT facilities - devel-

opment investments and productivity.

Hypothesis 3: The relationship between IT facilities - development investments and productivity is moderated by different economic contexts[9].

Hypothesis 4: This relation is not consistent among different sectors.

Focusing on the relationship between IT facilities/development investments and productivity, the research with the most important contributions conducted in the last two decades states that numerous empirical studies have examined the relationship between IT investments and firm productivity/performance at different methodologies, at various level of analysis, at a range of dependent variables, at more and more comprehensive independent variables, and under diversified contexts. In general, they found a significant effect of IT on productivity only in developed countries, not in developing countries. The reason may be that developing countries with higher capital costs and lower unit costs of labor face more difficulties for capital-labor substitutions (Dedrick et al., 2003).

3. Methodology

3.1. Research model

Fixed and random effects models are applied separately for different groups of independent variables, including IT facilities, development investments, firms' attributes, economic environment, and contextual variables.

Following Brynjolfsson and Hitt (1996), the regressions without *contextual moderators* are firstly estimated to evaluate whether the *direct effects* of IT facilities/development investments on productivity are similar to the prior findings (Dewan et al., 2007; Kothari et al., 2002; Kobelsky et al., 2008). The standard regression model for examining the "productivity paradox" can be formulated as follows:

$$LP_{it} = \alpha_i + \delta_t + \beta_1 IT_{it} + \varepsilon_{it} \qquad \text{(III-1)}$$

Where LP_{it} is labor productivity of firm i at time t. α_i and δ_t represent individual and time effects, respectively. IT_{it} denotes group of IT facility variables of firm i at time t, including the number computer per employee (Co_{it}), internet access (In_{it}) and LAN connection (La_{it}). My first *hypothesis* is that *IT facilities and development investments have positive effects on firm productivity* which means that β_1 has a positive value (β_1>0). ε_{it} is a random disturbance and is assumed to be normal, independent and identically distributed (IID) with $E(\varepsilon_{it})= 0$ and $\text{var}(\varepsilon_{it}) = \sigma_\varepsilon^2 > 0$

To answer the second *hypothesis*, "favorable firm attributes and globalization factors improve productivity and the relationship between IT facilities - development investment and productivity", variables of internal-firm factors (firm's attributes) and external-firm factors (globalization variables) are inserted:

$$LP_{it} = \alpha_i + \delta_t + \beta_1 IT_{it} + \beta_2 At_{it} + \beta_3 Glo_{it} + \varepsilon_{it} \qquad \text{(III-2)}$$

In (III-2), At_{it} represents firm attributes, such as capital intensity, total assets, total fixed assets and long-term investments, labor quality and leverage. Glo_{it} illustrates macroeconomic/globalization factors, including market size and trade growth.

Following Kobelsky et al. (2008), the third *hypothesis,* the relationship between IT facilities and firm productivity is moderated by different economic contexts is examined. Similarly to Kobelsky et al. (2008), this study also focuses on firm-level moderating effects. Thus contextual moderator factors are inserted in the model, yielding the following formula:

$$LP_{it} = \alpha_i + \delta_t + \beta_1 IT_{it} + \beta_2 At_{it} + \beta_3 Glo_{it} + \beta_4 (Co_{it} * Mo_{it}) + \varepsilon_{it} \qquad \text{(III-3)}$$

Function (III-3) answers the central question that how the effect of IT facilities on pro-

ductivity changes after controlling contextual moderating effects. The multiplicative term, $Co_{it} * Mo_{it}$, is said to encompass the interaction effect, or presence of a moderated relationship (Jaccard et al., 2003). Mo_{it} includes firm attributes, LAN connection, and internet access. To evaluate moderating relationships, firstly, the paper follows Kobelsky et al. (2008) to investigate firm attributes, including capital intensity, firm size, and labour quality. Secondly, the paper attempts two IT facilities, the internet access and LAN connection, because these factors have intimate relationships with computers. These factors could not function without computers and represent the level and scale of accessing IT. Furthermore, these factors measure the extent level to which firms have been made IT available to their managers and employees. The value of β_4 indicates how the relationship between labor productivity and IT facilities varies across different economic contexts.

Similarly, the above steps are applied for variables of development investments, including total development investments; investment portfolios, including investments for equipment and machinery; construction; and research and development as follows:

$$LP_{it} = \alpha_i + \delta_t + \gamma_1 DI_{it} + \gamma_2 At_{it} + \gamma_3 Glo_{it} + \gamma_4 (RD_{it} * Mo_{it}) + \varepsilon_{it} \quad \text{(III-4)}$$

Where DI_{it} is the group of development investment variables of firm i at time t, including total development investments (To_{it}), R&D investment rate (RD_{it}), Equipment investment rate (Eq_{it}), Construction rate (Cs_{it}).

Finally, formulas (III-3) and (III-4) are applied separately for two main sectors in the economy, the manufacturing and the commercial-service sectors, to test the final hypothesis as well as to facilitate the comparison with other studies' results.

3.2. Variables

In this study, dependent variable is labor productivity which is measured by total sales divided by the number of employees. Compared with multifactor productivity, this measurement is more advantageous in terms of comparability, that is, it scales the outputs of firms in all industries to the comparable one; and in terms of more sensitive response to any change of IT investments (Triplett, 1999). It is the reason why many IT investment studies have used this definition (Kraemer and Dedrick, 1994; Doms et al., 2003; Hu an Quan, 2005; Aral and Brynjolfsson, 2006). Regarding independent variables, they are theoretically driven, see Table III.2.

This study employs the IT concept concerning technology facilities, namely computer, internet access, and LAN connection. The first facility, computer, is "best described as a general-purpose technology"[10]. The second facility, internet access, is one of the most effective ways to communicate, update, collect, and exchange information all over the world. The third facility, LAN connection, helps to exchange powerful information within local areas/company. While the number of computers per employee measures the coverage of which users can access to IT, the internet access and LAN connection represents the level and scale of accessing IT and estimates the level to which a firm make IT available.

Moreover, in contrast to most of the existing literature that mainly consider patents or R&D in the relationship with firm productivity[11], this study employs the actual development investment portfolios, including investments for research and development (R&D); equipment and machinery; and construction. R&D investment has been considered a key measure of the current condition of technical knowledge of firms (Griliches, 1979). The higher

Table III.2: Variables

Variable name	Explanations
Dependent variable	
Labor productivity	Labor productivity is measured by total sales divided by number of employees.
Independent variable	
IT facilities	
Computer per capita (Com)	Number of computers per employee
LAN connection	Dummy variable: 1 if LAN connection is available; 0: otherwise
Internet access	Dummy variable: 1 if Internet is available; 0: otherwise
Development investment	
Total development investments	Total investment capital for development
R&D investment rate (RD)	The ratio of R&D investment per total development investments
Equipment investment rate	The ratio of equipment and machine investment per total development investments
Construction rate	The ratio of construction investment per total development investments
Sectors	
Manufacturing	Dummy variable: 1 if sector is manufacturing; 0: otherwise
Commercial	Dummy variable: 1 if sector is commercial; 0: otherwise
Firm's attributes -contextual moderators	
Capital intensity	Capital intensity is measu red by total fixed assets divided by number of employees.
Firm size - Total assets per employee	Book value of total assets divided by the number of employees
Firm size - Total fixed assets and long term investments	Book value of total fixed assets and long term investments
Labor quality	Total income of employees per number of employees.
Leverage	The book values of total liabilities divided by total assets
Globalization factors	
Market size - competitiveness	Number of enterprises in each industry
Trade growth	Annual trade growth of economy

level of R&D a firm invests in, the more innovative and efficient it is expected. This paper will focus on whether innovative activity – in the sense of more R&D investment–delivers gains in productivity. In this paper, expenses for R&D are used to conduct mainly scientific and technological research, and technical and innovation programs. Expenses for equipment and machinery are spent mainly on purchasing, operating, and repairing technological equipment and machinery. Expenses for basic construction are invested mainly for designing and building projects.

In terms of a firm's attributes, the study employs some crucial internal factors on which the firm depends for survival. Because this study employs labor productivity (the total sales divided by total labor) as a proxy of firm performance, capital intensity (the ratio of capital to labor), is considered an important control variable[12]. Besides, labor quality is also a considered independent variable because it is a key determinant of international differences in productivity (Mitchell, 1968). Furthermore, under the process of trade liberalization, Vietnamese enterprises seriously require skilled labor. Following Wakelin (1998), the study uses average wage, the total earnings of employees per number of employees, to capture the labor quality. Furthermore, firm size may moderate the effect of IT/development investments on productivity. Besides, the increasing competition under the process of trade liberalization may cause a financial risk which leads to an adjustment of financial structure. In this study, leverage as a proxy for the financial risk is measured by the book values of total liabilities divided by total assets.

In addition, in the present study, the globalization effects on an economy are expressed mainly by trade growth of the whole economy and competition levels. In this paper, the competition level is measured by the number of enterprises in each industry. All financial variables are deflated by the annual consumer

Table III.3: Descriptive Statistics

Description	Mean	Std. Dev.	Minimum	Maximum
Labor productivity (millions VND)	360.87	858.55	0.336506	40,748
Computer per capita	0.10	0.17	0	3
LAN connection	0.40	0.49	0	1
Internet access	0.58	0.49	0	1
Total development investment (millions VND)	8,676.87	46,308.00	0.999001	3,673,061
R&D investment (RD) (millions VND)	4,651.02	31,420.50	0	2,915,863
Equipment investment (millions VND)	1,841.89	15,960.23	0	1,157,217
Construction investment (millions VND)	2,209.30	19,586.69	0	1,573,073
Capital intensity	62.25	223.09	0.02	8,859
Total assets per employee	108.59	392.71	0.02	16,035.65
Labor quality	15.71	14.26	0.035121	350
Total fixed assets & long -term investment (millions VND)	34,899.47	153,126.60	0.796813	6,368,266
Leverage	53.89	27.81	0	100
Market size - competitiveness	1,527.60	993.18	24	5,936
Trade growth	1.60	0.46	1.037	2

Table III.4: Effects of IT Facilities on Productivity

Dep. Var.: Labor Productivity	IT	Firm's features	Globalizatio n factors	Context
Exp. Vars.	**(1)**	**(2)**	**(3)**	**(4)**
IT facilities				
Computer per capita (Com)	0.9770***	0.2326***	0.0903*	0.3678*
	(0.061)	(0.054)	(0.054)	(0.204)
LAN connection	0.0700***	0.0595***	0.0178	0.0306**
	(0.014)	(0.012)	(0.013)	(0.015)
Internet situation	0.0619***	0.0595***	0.0268**	0.0376**
	(0.015)	(0.013)	(0.013)	(0.016)
Sectors				
Manufacturing	-0.0341	-0.0059	-0.0367	-0.0356
	(0.053)	(0.045)	(0.052)	(0.052)
Commercial	0.2004***	0.2029***	0.1609***	0.1720***
	(0.051)	(0.044)	(0.057)	(0.057)
Firm's features				
Capital intensity		0.1558***	0.1292***	0.1457***
		(0.012)	(0.012)	(0.014)
Labor quality		0.4114***	0.3808***	0.3871***
		(0.010)	(0.010)	(0.011)
Firm size 1[x]		0.2798***	0.3461***	0.3465***
		(0.015)	(0.016)	(0.017)
Firm size 2[xx]		-0.2496***	-0.3318***	-0.3369***
		(0.011)	(0.012)	(0.012)
Leverage		0.3407***	0.2861***	0.2868***
		(0.026)	(0.026)	(0.026)
Globalization factors				
Market size			0.0196	0.0222
			(0.020)	(0.020)
Trade growth			0.1439***	0.1303***
			(0.013)	(0.014)
Moderating effects				
Com*LAN				-0.1394*
				(0.072)
Com*Internet				-0.2003*
				(0.110)
Com* Capital_intensity				-0.1659***
				(0.049)
Com*Firm_size_1				-0.2234***
				(0.060)

Com*Labor_quality				-0.1104***
				(0.041)
Com*Firm_size_2				0.2335***
				(0.038)
Constant	4.7378***	4.1823***	4.5034***	4.4514***
	(0.030)	(0.074)	(0.167)	(0.172)
Observations	15140	15140	15140	14805
R^2	0.030	0.284	0.301	0.304

Note: Standard errors are in parentheses. (*), (**), and (***) denote statistical significance at least at the 10%, 5%, and 1% levels, respectively. (^{X}), (^{XX}) denote Total assets per employee, Total fixed assets & long-term investment, respectively. Model (1) presents effects of IT facilities on Productivity without other factors' effect. Model (2) evaluates how the relationship between IT facilities and Productivity changes under effect of firm's attributes. Model (3) investigates how this relationship changes under effect of Globalization factors. Final model illustrates how contextual factors moderate this relationship.

price index (CPI). Variables including labor quality, labor productivity, total assets, total fixed assets & long-term investment, capital intensity, market size are expressed *in logarithm* form.

3.3. Data

The panel firm-level data employed in this paper are extracted from the National census of enterprises in Vietnam during the period 2001-2005. This census is conducted by the Vietnam Government Statistics Organization. It investigates all enterprises, namely State owner Enterprises, joint stock companies, private enterprises, co-operatives, limited liability companies, partnerships, and foreign-invested enterprises. These enterprises operate throughout the country in all sectors of the national economy. For the purpose of empirical research, cleaning procedures are followed. Observations with either non-positive or missing values for the variables employed (number of employees, earning, sales, total assets, fixed assets, and liabilities) are excluded. Besides, the data is limited to surviving enterprises to pave the way for analysis of the persistence of productivity during the observed time. Finally, the used dataset is a balanced panel data with 15,140 observations of 3,028 firms with descriptive statistics in Table III.3.

4. Empirical results and discussion

This section applies the fixed and random effects models for simple and multiple regressions for Vietnamese enterprises. The estimates are displayed from the simple model to the multiple ones by inserting stepwise groups of variables to evaluate the change of factor effects in various economic contexts. The output is presented separately for IT facilities and development investments, the manufacturing and commercial-service sectors, to facilitate comparisons with each other.

4.1. Relationship between IT facilities and labor productivity

This section focuses on empirical results of the relationship between labor productivity and IT facilities (see Table III.4). Model (1) presents the effects of IT facilities on productivity without other considering other effecting elements. Inserting more effects of firm's attributes, model (2) evaluates how the rela-

tionship between IT facilities and productivity changes. Model (3) investigates how this relationship changes under the effects of globalization factors. The final model illustrates how contextual factors moderate this relationship.

In Table III.4, generally, all IT facilities have positive affects on labor productivity, thus this supports the first hypothesis. Their strongest effects are expressed in model (1). These effects gradually decrease in models (2-3) under the circumstances of a firm's features and globalization factors, even effect of *LAN connection* turns to be insignificant in model (3). Particularly prominent is the role of the computer in increasing productivity. In all models, the coefficients of *Com* are significant positive and strongest compared with other IT facilities. In the model 4, in combination with all other factors, the coefficient reaches the value of 0.3678, the second highest compared with other effects in this model (the strongest effect, with value of 0.3871, belongs to labor quality). In other words, among various significant factors, using computers contributes to productivity.

The models (2-3) give the answer for the second hypothesis[13]. In the context of main firm's attributes, all IT facilities' effects on labor productivity decrease. In other words, this evidence does not support the second hypothesis. However, all IT facilities' effects are still significant and positive. Similarly to computers, capital intensity, total assets, labor quality, and leverage significantly improve productivity. However, in the context of globalization, in model (3), LAN connection's effect on productivity turns to be insignificant. The reason may be that the LAN connection only functions within the local area/company, while globalization requires no limit in exchanging information, thus its contribution it becomes insignificant. Besides, there is difference of productivity among various sectors, that is, productivity seems generally higher in the commercial sector compared with that of the manufacturing one. It may result from the fact that total sales in the commercial sector are normally higher than that in the manufacturing one, while productivity in this paper is measured by total sales divided by the number of employees.

With respect to the third *hypothesis* that the relationship between IT facilities and productivity is moderated by different economic contexts, model (4) provides evidence to support it. In this model, all IT facilities' effects are significant and positive and seem higher compared with those in models (2-3). In model 4, other firm's attributes retain their significant signs and strength compared with those in the previous models. Besides, all contextual factors are significant, indicating the third hypothesis is valid. In addition, most moderator variables have significant and negative impact on the relationship of IT facilities on labor productivity, except fixed assets and long-term investments. Generally, it implies that these variables reduce the effects of IT facilities on productivity. More computers connected in a LAN system do not seem to increase labor productivity. While total assets have negative moderating effects, fixed assets and long-term investments have positive ones, it could be explained that the negative moderating impact may result from short-term investments.

In short, IT facilities' impacts on productivity are sensitive in relation to different contexts. However, it still opposes evidence for the productivity paradox for Vietnamese enterprises. Similarly in computerization, total assets per employee and labor quality are con-

Table III.5: Effects of Development Investments on Productivity

Dep. Var.: Labor Productivity	**Dev. Inv.**	**Firm's features**	**Globalizatio n factors**	**Context**
Exp. Vars.	(1)	(2)	(3)	(4)
Development investments				
Total Development investments	0.0073**	0.0004	0.0064**	0.0066**
	(0.003)	(0.003)	(0.003)	(0.003)
R&D investment rate (RD)	0.2002***	0.1380***	0.0740***	0.3478***
	(0.015)	(0.013)	(0.014)	(0.045)
Equipment investment rate	-0.0048	-0.0387**	-0.0419**	-0.0569***
	(0.021)	(0.018)	(0.018)	(0.018)
Construction investment rate	0.1018***	0.0759***	0.0186	0.0112
	(0.022)	(0.019)	(0.020)	(0.020)
Sectors				
Manufacturing	-0.0579	0.0001	-0.0167	-0.0211
	(0.053)	(0.045)	(0.052)	(0.052)
Commercial	0.1991***	0.2025***	0.1818***	0.1866***
	(0.051)	(0.044)	(0.056)	(0.057)
Firm attributes				
Capital intensity		0.1432***	0.1261***	0.1096***
		(0.012)	(0.012)	(0.015)
Labor quality		0.3977***	0.3752***	0.4195***
		(0.010)	(0.010)	(0.013)
Firm size^{x}		0.3205***	0.3610***	0.3469***
		(0.015)	(0.015)	(0.019)
Firm size^{xx}		-0.2867***	-0.3479***	-0.3314***
		(0.011)	(0.012)	(0.013)
Leverage		0.3261***	0.2822***	0.2780***
		(0.026)	(0.026)	(0.026)
Globalization factors				
Market size			0.0098	0.0179
			(0.020)	(0.020)
Trade growth			0.1308***	0.1207***
			(0.013)	(0.014)
Moderating effects				
RD*LAN				0.0342**
				(0.013)
RD*Internet				0.0238*
				(0.014)
RD*Capital_intensity				0.0206
				(0.016)
RD*Labor_quality				-0.0755***

				(0.013)
RD*Firm_size_1				0.0298*
				(0.017)
RD*Firm_size_2				-0.0350***
				(0.007)
Constant	4.6970***	4.4086***	4.6499***	4.4715***
	(0.041)	(0.074)	(0.166)	(0.171)
Observations	15140	15140	15140	14805
R^2	0.029	0.293	0.305	0.309

Note: Standard errors are in parentheses. (*), (**), and (***) denote statistical significance at least at the 10%, 5%, and 1% levels, respectively. (^{X}), (^{XX}) denote Total assets per employee, Total fixed assets & long-term investment, respectively. Model (1) presents effects of development investments on Productivity without other factors' effect. Model (2) evaluates how the relationship between development investments and Productivity changes under effect of firm's attributes. Model (3) investigates how this relationship changes under effect of Globalization factors. Final model illustrates how contextual factors moderate this relationship.

sidered important determinants of productivity.

4.2. Relationship between development investments and labor productivity

In attempt to avoid the mis-measurement of IT as mentioned by Brynjolfsson (1993)[14], the study replicates the above empirical analysis for development investments, including investment for R&D; equipment and machinery; and construction. In other words, this section presents the impact of development investments on labor productivity. In Table III.5, model (1) presents the effects of development investments on productivity without other factors' effect. Model (2) evaluates how the relationship between development investments and productivity changes under the effects of firm's attributes. Model (3) investigates how this relationship changes under the effects of globalization factors. The final model illustrates how contextual factors moderate this relationship.

Table III.5 shows that, in general, a firm with higher total development investments, especially with higher share of R&D investment, will have higher labor productivity. While equipment investment rates have negative effects (models 2-4), construction investment rates have insignificant and positive effects on labor productivity (models 3-4). It implies that to improve labor productivity, a firm should invest more in R&D rather than in other kinds of development investments. The effect of the share of R&D investment on labor productivity is significantly stronger than that of other shares of development investment portfolios. Therefore, the first hypothesis is only supported by the results of total development investments and R&D investment rate.

However, the models (2-3) imply that under the effects of a firm's attributes and globalization factors, the positive effects of development investments decrease, which is opposite to the second hypothesis. In model 2, while positive coefficient of total development investments turns to be insignificant, the negative effect of equipment investment rate

becomes stronger. In addition, productivities are different among various sectors, in the details, productivity is generally higher in the commercial sector compared with that in manufacturing. Besides, a firm's attributes have similar effects on labor productivity to those in the previous section. In model 3, under the effects of globalization factors, the effects of development portfolios fluctuate slightly. The effect of total development investments increases but the effect of R&D investment rates decrease weakly. Besides, a firm's attributes will have similar effects to those in model 2. In addition, globalization factors in terms of trade growth have significant and positive impacts on productivity. Thus, the second hypothesis is not supported.

Finally, the model (4) expresses that the *third hypothesis*[15] is supported. The effect of R&D investment rate on labor productivity depends on some moderators: LAN connection, internet access, total assets, labor quality, total fixed assets and long-term investments due to their significant coefficients. While LAN connection, internet access, and total assets support the effects of R&D investment rates on labor productivity, total fixed assets and long-term investments, and labor quality do not. It may suggest that the LAN connection is a useful way for members in a R&D project to contact and exchange information in research and study.

In short, the productivity paradox does not appear for the case of total development investments and the share of R&D investment for Vietnamese enterprises. However, these effects are slightly weaker than those of IT facilities are. Besides these factors, total assets per employee and labor quality are important determinants of productivity.

4.3. Comparative analysis for different sectors

Because scale economies affect the manufacturing and commercial-service sectors differently, the mean efficient size of commercial-service firms is different from manufacturing ones (Teruel-Carrizosa, 2008). Due to their distinction, the study replicates the empirical study for these sectors separately, see Table III.6. Model (1) presents the effect of IT facilities on productivity in the manufacturing sector. Model (2) illustrates the effect of development investments on productivity in the manufacturing sector. Model (3) examines the effect of IT facilities on productivity in the commercial-service sector. The final model investigates the effect of development investments on productivity in the commercial-service sector.

In general, the empirical results show the distinction between two sectors, the manufacturing and the commercial-service firms. Regarding IT facilities, computer per employee contributes to productivity for the manufacturing but not for the commercial-service firms in models (1, 3). The reversed situation happens for LAN connection and Internet situations; they are insignificant for the manufacturing but significant and positive for the commercial-service firms. With respect to development investments, the results are the same for both sectors. Only R&D investment rates has a positive and significant effect on productivity, other portfolios have insignificant effects. Therefore the *first hypothesis*[16] depends on the types of IT facilities/development investments, and factors. In terms of firm attributes, the results express the similarity in all cases, that is, almost variables, excluding total fixed assets and long-term investments, support productivity. Regarding globalization factors,

Table III.6: Effects of IT Facilities and Development Investments in Different Sectors

Dep. Var.: Labo r Productivity	Manufacture-IT	Manufacture-Dev. Inv	Commercial -IT	Commercial - Dev. Inv
Exp. Vars.	**(1)**	**(2)**	**(3)**	**(4)**
IT facilities				
Computer per capita (Com)	2.1683***		0.5998	
	(0.683)		(0.478)	
LAN connection	0.0174		0.1100***	
	(0.021)		(0.042)	
Internet situation	0.0061		0.1060**	
	(0.024)		(0.046)	
Firm attributes				
Capital intensity	0.1383***	0.1230***	0.1814***	0.0792**
	(0.022)	(0.023)	(0.034)	(0.037)
Labor quality	0.4728***	0.4970***	0.3103***	0.3098***
	(0.018)	(0.020)	(0.034)	(0.033)
Firm size 1 [x]	0.1824***	0.1598***	0.3897***	0.4817***
	(0.029)	(0.028)	(0.046)	(0.047)
Firm size 2 [xx]	-0.1756***	-0.1739***	-0.4570***	-0.4586***
	(0.021)	(0.021)	(0.035)	(0.034)
Leverage	0.1534***	0.1566***	0.6549***	0.6754***
	(0.036)	(0.036)	(0.078)	(0.077)
Globalization factors				
Market size	4.2419***	3.6025***	-1.6556***	-1.2184***
	(0.471)	(0.534)	(0.384)	(0.390)
Trade growth	-1.7982***	-1.4969***	1.0495***	0.7905***
	(0.216)	(0.243)	(0.222)	(0.228)
IT & moderating effects				
Com*LAN	-0.2302		-0.2902**	
	(0.201)		(0.147)	
Com*Internet	0.1687		-0.3572	
	(0.290)		(0.293)	
Com* Capital_intensity	-0.3951*		-0.2720***	
	(0.219)		(0.101)	
Com*Labor_quality	-0.5269***		-0.0248	
	(0.146)		(0.098)	
Com*Firm_size_1	-0.2348		0.0698	
	(0.239)		(0.140)	
Com*Firm_size_2	0.2819**		0.1161	
	(0.110)		(0.099)	
Development investments				
Total Development investments		0.0041		-0.0069
		(0.005)		(0.007)
R&D investment rate (RD)		0.2930***		0.4818***
		(0.070)		(0.118)

Equipment investment rate		-0.0042		-0.0051
		(0.026)		(0.057)
Construction investment rate		0.0000		-0.0101
		(0.029)		(0.053)
RD & moderating effects				
RD*LAN		0.0215		0.1064***
		(0.019)		(0.033)
RD*Internet		0.0047		0.0513
		(0.021)		(0.036)
RD*Capital_intensity		-0.0261		0.0351
		(0.028)		(0.038)
RD*Labor_quality		-0.1014***		-0.0297
		(0.020)		(0.033)
RD*Firm_size_1		0.0787***		0.0122
		(0.029)		(0.041)
RD*Firm_size_2		-0.0240**		-0.0713***
		(0.010)		(0.019)
Constant	-34.5909***	-28.7762***	22.1027***	18.1462***
	(4.220)	(4.791)	(3.649)	(3.698)
R^2	0.271	0.272	0.305	0.312
Observations	6592	6592	2077	2077

Note: Model (1) presents the effect of IT facilities on productivity in the manufacturing sector. Model (2) presents the effect of development investments on productivity in the manufacturing sector. Model (3) presents the effect of IT facilities on productivity in commercial-service sector. Model (4) presents the effect of development investments on productivity in commercial-service sector. Final model presents the effect of development investments on productivity in commercial-service sector.

these sectors are distinguished. While higher market size, in terms of number of enterprises, will generally support firms to have higher productivity in the manufacturing sector rather than in the commercial one, higher trade growth of economy will seem to only support the commercial sector. It may suggest that higher market size implies that the products which firms are producing are in the growing stage in life cycle, thus leading to increased productivity in the manufacturing sector. Besides, higher trade growth of the whole economy probably results from the upward trend in total sales or productivity (measured by total fixed assets divided by number of employees) in the commercial sectors

In addition, two sectors are distinct in terms of moderating effects. Labor quality, and fixed assets and long-term investments have significant moderating effects on the relationship between IT facilities and productivity for the manufacturing but not for the commercial-service firms. Total assets and labor quality have significant moderating effects on the relationship between development investments and productivity for the manufacturing but not for the commercial-service firms. Thus, the *fifth hypothesis* seems reasonable for the case of IT facilities but not for the case of development investments. The negative moderating coefficient of *Com*LAN (*particularly with insignificant coefficient of *Com* for commer-

cial sector) implies that a higher number of computers, raising higher expenditures spent on these computers, seems helpless to increase productivity (particularly for the commercial sector), even when a firm uses LAN, it requires fewer computers to run the business effectively. This appears the same for the case of moderating effects of capital intensity and labor quality on the relationship between computer and labor productivity. It is similar for the case of moderating effects of labor quality and total fixed assets and long-term investment on the relationship between R&D investment and productivity. It may implies that higher labor quality or more investing on fixed assets and long-term portfolios seem the better alternative to improve productivity rather than investing on R&D which is extremely costly while having a low probability of success.

5. Conclusions

The "productivity paradox" presents the contradiction that increases in firm IT investments have not been combined with increases in its productivity (Brynjolfsson, 1993). This paper responds to growing calls for further research on the assessment of this "productivity paradox" and how organizational context moderate this "paradox" (Orlikowski and Iacono, 2002; Kobelsky et al., 2008). This study contributes to the understanding of the relationship between IT facilities/development investments and firm productivity.

In short, for the case of Vietnamese enterprises, the "productivity paradox" does not occur for R&D investments of all firms, for computerization for the manufacturing firms, for LAN connection and Internet situations for the commercial-service firms. Therefore, the implication for managers who aim at increasing labor productivity is that an increase in R&D investment rate seems appropriate. Besides, managers in the manufacturing sector should consider enhancing computerization, while managers in the commercial-service sector should pay attention to apply LAN and internet connections. Besides, for business management, our findings suggest about the mechanism of contextual moderators by which IT facilities/development investments contribute more benefits to productivity. This suggestion is useful to improve managerial skills. In the details, to moderate computerization effect on labor productivity in manufacturing firms, more fixed assets and long-term investment may be necessary. In addition, to enhance the effect of R&D investment on labor productivity, increasing total assets per capita could be useful.

There are some limitations of this study. Due to the limitation of the data, the employed IT measurements are only based on the number of computers not the IT expenditure, thus it does not account for the differences of computer technology levels which could be estimated by its expenditure. Therefore, the high technology computer is equal to the normal one in the valuation. Besides, because of the limitation of the data, the study is able to measure only labor productivity, which only investigates one of three main factors of production, labor, while total factor productivity (TFP) covers all these factors. Moreover, due to the limited data, this paper could not examine the effect of IT personnel which is an important measure of IT nowadays. Further investigation of contextual moderating factors relative to outside external factors should be considered.

Note:

[1] Brynjolfsson (1993, pp. 67)

[2] Labour and Social Trends in Viet Nam 2009/10, 2010.

[3] http://vietnambusiness.asia/productivity-low-despite-high-gains/

[4] Ghosa and Nair-Reichert, 2008

[5] Dedrick et al., (2003, pp. 4)

[6] Brynjolfsson (1993, pp. 67)

[7] Loukis et al., (2009, pp 195)

[8] According to Jaccard et al. (2003), there are some main types of relationship in statistics. A *direct* causal relationship is one in which a variable, *X*, is a direct cause of another variable, *Y*. An *indirect* causal relationship is one in which *X* exerts a causal impact on *Y*, but only through its impact on a third variable, *Z*. A *moderated* causal relationship, or interaction effects, is one in which the relationship between *X* and *Y* is moderated by a third variable, *Z*.

[9] Economic contexts here are at firm level and time-variable.

[10] Brynjolfsson and Hitt (2003, pp. 793)

[11] Ghosa and Nair-Reichert, 2008

[12] The reason is that a firm with a higher capital-stock usually produce higher level of output for a given amount of labor, leading higher labor productivity (Ghosal and Nair-Reichert, 2009, pp. 540).

[13] Favorable firm attributes and globalization factors improve productivity and the relationship between IT facilities - development investments and productivity.

[14] Brynjolfsson (1993) postulate that there may be four reasons for the productivity paradox: (1) Mismeasurement of outputs and inputs; (2) Lags due to learning and adjustment; (3) Redistribution and dissipation of profits; (4) Mismanagement of information and technology.

[15] This relationship is moderated by different economic contexts.

[16] IT facilities, development investment have positive effects on firm productivity.

References

Anagnostopoulou, S. C. and Levis, M. (2008), 'R&D and productivity persistence: Evidence from the United Kingdom,' *The International Journal of Accounting*, 43, 293–320.

Aral, S. and Brynjolfsson, E. (2006), 'Which came first, it or productivity? The virtuous cycle of investment and use in enterprise systems', *Twenty Seventh International Conference on Information Systems*, Milwaukee

Baughn, C., Lim, V., Le, L., Neupert, K., and Woods, S. (2004), 'Identification of entrepreneurial opportunities in Asia: a look at the Philippines and Vietnam. In Butler, J. (Ed.)', *Opportunity Identification and Entrepreneurial Behavior: A Volume in Research in Entrepreneurship and Management*, (pp. 191-218). Information Age Publishing: Greenwich.

Bharadwaj, A. (2000), 'A resource based perspective on information technology capability and firm performance: an empirical investigation,' *MIS Quarterly* 24 (1), 169–196.

Bresnahan, T. F. (1997), 'Computerization and wage dispersion: An analytical reinterpretation', *Economic*

J.: J. Royal Econ. Soc. 109, 456, F390–F415.

Brynjolfsson, E. (1993), 'The Productivity Paradox of Information Technology', *Communications of the ACM*, 36 (12), 66–77.

Brynjolfsson, E. and Hitt, L. (1995), 'Information Technology as a Factor of Production: The Role of Differences among Firms', *Economics of Innovation and New Technology*, 3 (4), 183-200.

Brynjolfsson, E., and Hitt, L. (1996), 'Paradox Lost? Firm-Level Evidence on the Returns to Informa- tion Systems Spending', *Management Science, 42(4)*, 541- 558.

Brynjolfsson, E., and Hitt, L.M. (2003), 'Computing Productivity: Firm-Level Evidence', *The review of economics and statistics, 85* (4), 793-808.

Dedrick, J., Gurbaxani, V., and Kraemer, K. L. (2003), 'Information Technology and Economic Performance: A Critical Review of the Empirical Evidence', *ACM Computing Surveys,* 35(1), 1–28.

Devaraj, S. and Kohli, R., (2000), 'Information technology payoff in the health-care industry: a longitudinal study', *J. Manage. Inf. Syst*., 16 (4), 41–67.

Dewan, S. and Kraemer, K. L. (1998), 'International Dimensions of the Productivity Paradox', *Communications of the ACM*, 41 (8), 56-62.

Dewan, S., Shi, C. and Gurbaxani, V. (2007), 'Investigating the Risk–Return Relationship of Information Technology Investment: Firm-Level Empirical Analysis', *Management science*, 53 (12), 1829–1842.

Doms, M. E. et al., (2003). IT investments and Firm Productivity in U.S. Retail Trade Center for Economic Studies, U.S. Census Bureau November 2003. FRPSF Working paper 2003-19

General Statistical Office (GSO) (2009), *Statistical Yearbook 2000*, Statistical Publishing House, Hanoi

Ghosal, V. and Nair-Reichert, U. (2009), 'Investments in modernization, innovation and gains in productivity: Evidence from firms in the global paper industry', *Research Policy*, 38, 536–547

Gordon, R. J., (1999). Has the 'New Economy' Rendered the Productivity Slowdown Obsolete? Northwestern University working paper. Accessed 22 July 2010 at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.163.4854andrep=rep1andtype=pdf.

Griliches, Z. (1979), 'Issues in assessing the contribution of research and development to productivity growth', *Bell Journal of Economics*, 10(1), 92–116.

Gurbaxani, V. and Whang, S. (1991), 'The impact of information systems on organizations and markets', *Commun. ACM, 34 (1),* 59–73.

Hitt, L.M. and Brynjolfsson, E. (1996), 'Productivity, business profitability, and consumer surplus: three different measures of information technology value', *MIS Quarterly* 20 (2), 121–142.

Hu, Q. and Plant, R. (2001), 'An empirical study of the causal relationship between IT investments and firm performance', *Information Resources Management Journal,* 14(3), 15–26.

Hu, Q. and Quan, J.J. (2005), 'Evaluating the impact of IT assets on productivity: A causal analysis at industry level', *International Journal of Information Management, 25,* 39–53.

Huang, S.M., Ou, C.S., Chen, C.M. and Lin, B. (2006). An empirical study of relationship between IT investments and firm productivity: a resource-based perspective. *Eur.* J. Oper. Res. 173 (3), 984–999.

Jaccard, J., Turrissi, R., and Wan C.K. (2003). Interaction effects in multiple regression. Sage University Paper series on Quantitative Applications in the Social Sciences. 2nd ed. Newbury Park, CA: Sage; p. 07–72.

Kim, J.K., Xiang, J. Y. and Lee, S. (2009), 'The impact of IT investments on firm productivity in China: An empirical investigation of the Chinese electronics industry', *Technological Forecasting and*

Social Change, 76 (5), 678-687.

Ko, M., Clark, J.G., and Ko, D. (2008), 'Revisiting the impact of information technology investments on productivity: An empirical investigation using multivariate adaptive regression splines (MARS)', *Information resources management journal*, 21 (3), 1 -23.

Kobelsky, K., Hunter, S., and Richardson, V. J. (2008), 'Information technology, contextual factors and the volatility of firm performance', *International Journal of Accounting Information Systems*, 9, 154–174.

Kothari, S. P., Laguerre, T. E. and Leone, A. J. (2002), 'Capitalization versus expensing: evidence on the uncertainty of future earnings from current investments in PP&E versus R&D', *Rev Acc Stud*, 7, 355–82.

Kraemer, K. L. and Dedrick, J. (1994), 'Payoffs from investment in information technology: Lessons from Asia-Pacific region', *World Develop*. 22 (12), 19–21.

Kudyba, S., & Diwan, R. (2002a). Research report: Increasing returns to information technology. I*nformation Systems Research,* 13(1), 104–111.

Kudyba, S., and Diwan, R. (2002b). The impact of information technology on US industry. *Japan and the World Economy*, *14*, 321–333.

Kudyba, S., and Diwan,R.(2002c). Information technology, corporate productivity, and the new economy. Westport, CT: Quorum Books.

Kudyba, S., and Vitaliano, D. (2003), 'Information technology and corporate profitability: A focus on operating efficiency', *Information Resources Management Journal*, 16(1), 1–13.

Lee, B. and Menon, N. M. (2000). Information technology value through different normative lenses, *J. Manage. Inf. Syst.,* 16 (4), 99–119.

Lee, S. and Kim, S.H. (2006). A lag effect of IT investments on firm productivity. Inf. Resour. Manage. J., 19 (1), 43–69.

Lichtenberg, F. R., (1995), 'The Output Contributions of Computer Equipment and Personnel: A Firm-Level Analysis', *Economics of Innovation and New Technology, 3*, 201-217.

Loukis, E. N., Sapounas, I. A. and Milionis, A. E. (2009). The effect of hard and soft information and communication technologies investments in manufacturing business performance in Greece – A preliminary econometric study. Telematics and Informatics, 26, 193–210.

Loveman, G.W. (1994). An assessment of the productivity impact of information technologies, in: T.J. Allen, M.S. Morton (Eds.), *Information Technology and the Corporation of the 1990s*: Research Studies, MIT Press, Cambridge, MA, pp. 84–110.

Mahmood, M.A. and Mann, G.J. (1993). Measuring the organizational impact of information technology investment: an exploratory study. *J. Manage. Inf. Syst.*, *10* (1), 97–122.

Malone, T. W., Yates, J., and Benjamin, R. I. (1989), 'The logic of electronic markets', *Harvard Bus. Rev.* 67 (3), 166–172.

Menon, N.M. and Lee, B. (2000). Cost control and production productivity enhancement by IT investments and regulation changes: evidence from the healthcare industry, Decis. *Support Syst*., 30 (2), 153–169.

Mitchell, E. J. (1968), *Labor quality and the international structure of labor productivity and wages*, Santa Monica.

Oostendorp, R. H., Trung, T. Q., Tung, N. T. (2009). The Changing Role of Non-Farm Household Enterprises in Vietnam. *World Development, 37*, 3, 632–644.

Orlikowski, W. J. and Iacono, C. S. (2002). Research commentary: desperately seeking the "IT" in IT research — a call to theorizing the IT artifact. *Inf Syst Res,12(2)*, 121–34.

Osei-Bryson, K. and Ko, M. (2004). Exploring the relationship between information technology investments and firm productivity using regression splines analysis. *Inf. Manage., 42 (1),* 1–13.

Pohjola, M. (2001). Information technology and economic growth: A cross-country analysis. In *Information Technology and Economic Development.* M. Pohjola, Ed. Oxford University Press, Cambridge, U.K., 242–256.

Prattipati, S.N. and Mensah, M.O. (1997). Information systems variables and management productivity. Inf. Manage., 33 (1), 33–43.

Roach, S. S. (1987). America's technology dilemma: A profile of the information economy. *Morgan Stanley Special Economic Study* (April).

Roach, S. S. (1989). Pitfalls of the new assembly line: Can service learn from manufacturing? *Morgan Stanley Special Economic Study* (June 22).

Roach, S. S. (1991). Services under siege: The restructuring imperative. Harvard Bus. Rev. 39, 2 (Sept-Oct.), 82–92.

Schoonhoven, C. B. (1981). Problems with contingency theory: testing assumptions hidden within the language of contingency "theory". *Adm Sci Q* , 26, 349–77.

Shao, B. and Lin, W. (2002). Technical efficiency analysis of information technology investments: a two-stage empirical investigation. *Information and Management* 39, 391–401.

Sircar, S., Turnbow, J. L., and Bordoloi, B. (2000), 'A framework for assessing the relationship between information technology investmens and firm performance', *Journal of Management Information Systems*, 16 (4), 69-97.

Sriram, V. and Stump, R. (2004). Information technology investments in purchasing: an empirical investigation of communications, relationship and productivity outcomes. *Omega*, 32 (1), 41–55.

Strassmann, P. A. 1990, *The Business Value of Computers: An Executive's Guide*, Information Economics Press, New Canaan, CT.

Strassmann, P.A. (1997), *The Squandered Computer: Evaluating the Business Alignment of Information Technologies*, Information Economics Press, New Canaan, Connecticut.

Tam, K.Y. (1998). The impact of information technology investments on firm productivity and evaluation: evidence from newly industrialized economies. *Inf. Syst. Res.* 9 (1), 85–98.

Teo, T.S.H. and Wong, P.K. (1998). An empirical study of the productivity impact of computerization in the retail industry. *Omega, 26 (5)*, 611–621.

Triplett, J. E. (1999), 'The Solow Productivity Paradox: What do Computers do to Productivity?', T*he Canadian Journal of Economics*, 32 (2), 309 -334.

Wakelin, K. (1998). Innovation and export behaviour at the firm level. Research Policy, 26, 829-841.

Weill, P. (1992). The relationship between investment in information technology and firm productivity: a study of the valve the manufacturing sector . *Inf. Syst. Res., 3 (4),* 307–333.

Yongmei, L., Hongjian, L. and Junhua, H. (2008). IT Capability as Moderator Between IT Investment and Firm Performance. *Tsinghua science and technology*, 13 (3), 329-336.

Zhu, K. and Kraemer, K.L. (2002). E-commerce metrics for net-enhanced organizations: assessing the value of e-commerce to firm productivity in the the manufacturing sector . *Inf. Syst. Res. 13 (3)*, 275–295.