

ITS European conference
2014 in Brussels

Role of ICT in the Innovation Process Based on Firm-Level Evidence from Four ASEAN Economies: A SEM Approach

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Agenda

- Introduction
- Purpose of this study and literature view
- Hypotheses and methodology
- Summary of data
- Results of the estimations
- Conclusions

Introduction

- The East Asian countries need to transform into knowledge based economies.
- Firms have enhance their innovation capability for innovation.
- The factors promoting innovation obtain such as R&D, technology, managerial organization, human factors, and ICT use (Tidd, Bessant, and Pavitt, 2001; Christensen and Kaufman, 2009; Idota et al, 2013).
- Most new information is obtained from outside the firms (Chesbrough, 2006a, 2006b).
- The collaboration with MNCs (Multi-national corporations), universities, public research organizations, other local firms, and so on is indispensable for local firms in developing countries (Cohen and Levinthal, 1990; Zahra and George, 2002).

Purpose of this study

- Examine the relationship between the factors and innovation
- How ICTs, technology and organizational learning enhance product innovation and process innovation by sharing information and collaborating with outside organizations in ASEAN economies such as Vietnam, Indonesia, the Philippines, and Thailand.

Literature view I: innovation capability

- The **innovation capability** is defined as the ability to continuously transform knowledge and ideas into new products, processes, and systems (Lawson and Samson, 2001).
- This paper terms it as **internal innovation capability**, or **internal capability**, which is defined as an integrated ability of a firm to create innovation consisting of all resources, core competence, or competitiveness.

Literature view II: absorptive capability

- A part of internal capability was referred to as “absorptive capability” by Cohen and Levinthal (1990), Zahra and George (2002) and Christensen and Kaufman (2009).
- Christensen and Kaufman define it as a firm’s ability to reorganize the value of new external knowledge, and assimilate this for commercial benefit.

Literature view III: open innovation

- The collaboration with entities outside the firm such as other firms, universities, and local research institutions for the innovation process was analyzed in the framework of “open innovation” (Chesbrough, 2003, 2006a, 2006b).
- The concept of the open innovation is developed in accordance with the growth of the assembly and processing industries, which handle numerous parts and components, such as the automotive or electronics industries.

Literature view IV: ICT use

- ICT are indispensable for Innovation.
- (1) ICT promotes the efficiency of firms by sharing information among employees and employers, and activates communication.
 - ICT leads to the enhancement of knowledge management activities for innovation inside the firm.
- (2) ICT enables firms to share, exchange, and communicate with agents outside the firm, which connects it more tightly with other firms or universities, consultants, or research institutes.
 - Firms can absorb technology, know-how, and information from outside.

Literature view V: Problems of firms in the developing countries

- Firms in the developing countries have their own problems; a weak basis for internal capability, particularly due to a lack of technology, human resources, and knowledge infrastructure.
- The strategy of firms or governments in the less developed countries is different from those in the developed countries.

Innovation process in developing countries

- Ernest (2002) emphasizes blending diverse international and domestic sources of knowledge.
- Kesidoua and Szirmai (2008) also specifies two types of knowledge spillover in the Uruguay software industry; local and **international**, and they came to the conclusion that the latter is more important than the former.
- Pietrobelli and Rabellotti (2011) shows international knowledge spillover via **the global value chain**, which enhances innovation in the less developed economies.
- Srholec (2011) takes social factors such **as human capital or skill formation** in the innovation process into consideration.

The model I

- This paper examines **how ICT use, organizational learning, and capital goods enhance product as well as process innovation in the developing countries.**
- This paper attempts to identify **internal capability**, which includes
 - technological level such as capital goods**
 - organizational learning such as quality control,**
 - cross functional team**
 - ICT use**
- This paper emphasizes **agents outside the firm, which promote internal capability** via the transaction and knowledge channels (Tsuji and Miyahara, 2010, 2011).

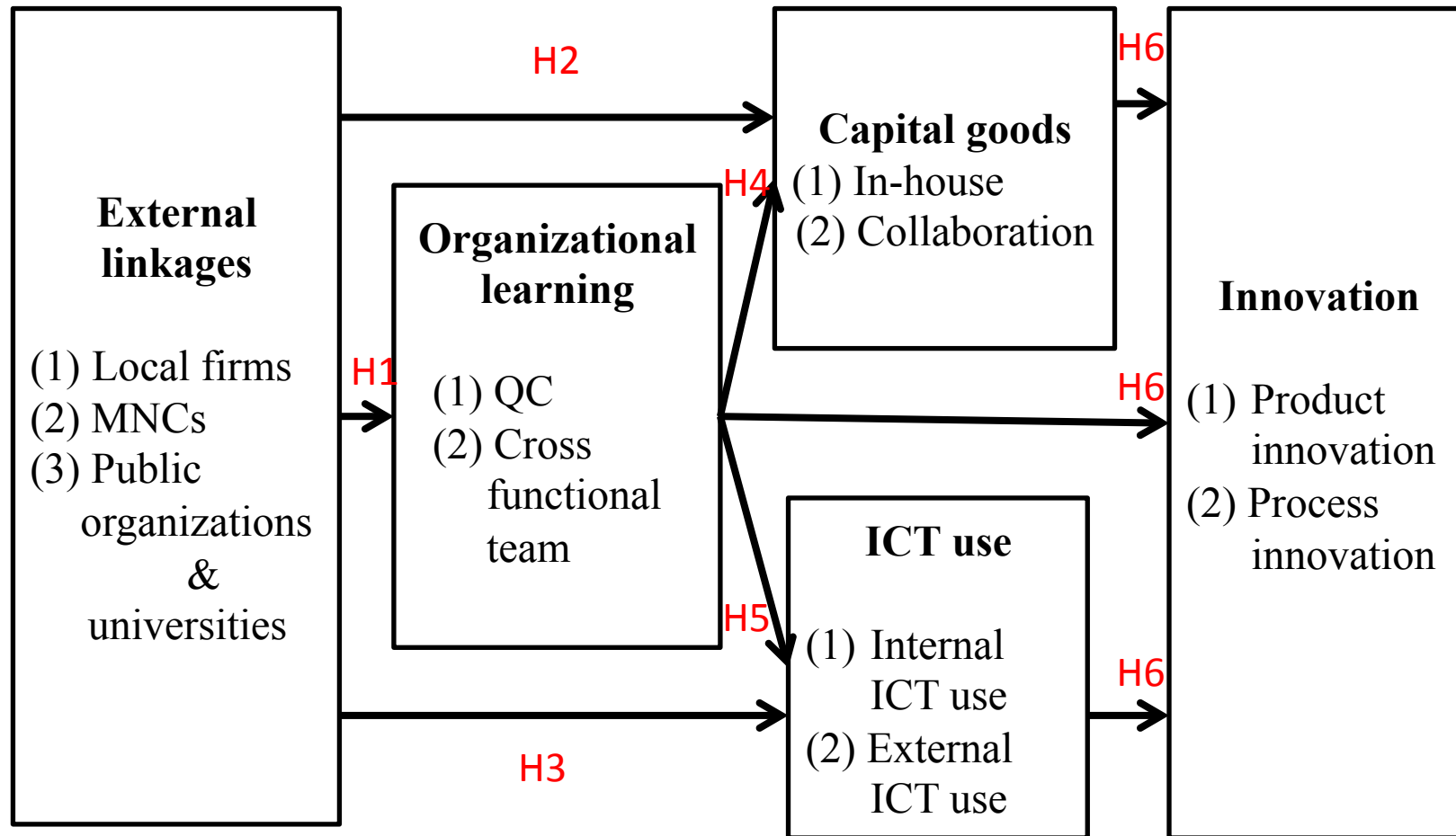
The model II

- The transaction channels transfer information from **agents via transactions or supply chains** (Pietrobelli and Rabellotti, 2011).
- The knowledge channels includes **MNCs, universities, regional research institutions, and business organizations**, which can transfer technology and other information to local firms.
- **The domestic effort by individual firms and external factors**, when assimilated, **enhances internal capability** so that the companies can create their own new products, services.

Hypotheses

- The following six hypotheses were examined in this study:
 - (H1) External linkages enhance organizational learning
 - (H2) External linkages improve capital goods
 - (H3) External linkages improve ICT use
 - (H4) Organizational learning improves capital goods
 - (H5) Organizational learning improves ICT use
 - (H6) Organizational learning, ICT use, and capital goods enhance innovation

Causal relationships



Methodology

- This study employs SEM (Structural equation modeling).
- It enables a study of the relationship among various variables that are related to each other.
- It is said to be a mixture of factor analysis and regression analysis; the former constructs latent variables from observed variables by using factor analysis, while the latter examines the causal relationship between latent variables by regression analysis.

Summary of data

- This study is based on mail surveys and phone interviews conducted with firms in four ASEAN countries, which are conducted by **ERIA** (Economic Research Institute for ASEAN and East Asia) from 2012 to 2013.
 - It amounts to;
 - Vietnam,
 - Hanoi, 1,132
 - Ho Chi Minh City, 1,000
 - Philippines, 239
 - Batangas and other areas
 - Indonesia, 437
 - Jabodetbek area
 - Thailand, 878
 - Greater Bangkok
- The total number of valid responses was 998 (26.36%).

Industries

	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Food, beverages, tobacco	14	4.4	17	16.3	13	9.1	17	6.7	61	7.4
Textiles	29	9.1	6	5.8	4	2.8	6	2.4	45	5.5
Apparel, leather	4	1.3	4	3.8	16	11.2	11	4.3	35	4.3
Footwear	3	0.9	1	1.0	3	2.1	3	1.2	10	1.2
Wood, wood products	5	1.6	1	1.0	1	0.7	9	3.6	16	2.0
Paper, paper products, printing	10	3.1	3	2.9	4	2.8	11	4.3	28	3.4
Chemicals, chemical products	17	5.3	10	9.6	7	4.9	8	3.2	42	5.1
Plastic, rubber products	45	14.1	11	10.6	11	7.7	11	4.3	78	9.5
Other non-metallic mineral products	6	1.9	1	1.0	8	5.6	5	2.0	20	2.4
Iron, steel	6	1.9	5	4.8	3	2.1	10	4.0	24	2.9
Non-ferrous metals	5	1.6	1	1.0	0	0.0	3	1.2	9	1.1
Metal products	22	6.9	6	5.8	26	18.2	6	2.4	60	7.3
Machinery, equipment, tools	34	10.7	7	6.7	4	2.8	19	7.5	64	7.8
Computers & computer parts	7	2.2	0	0.0	2	1.4	5	2.0	14	1.7
Other electronics & components	55	17.2	11	10.6	16	11.2	24	9.5	106	12.9
Precision instruments	6	1.9	0	0.0	0	0.0	0	0.0	6	0.7
Automobile, auto parts	12	3.8	7	6.7	10	7.0	35	13.8	64	7.8
Other transportation equipments and parts	30	9.4	5	4.8	3	2.1	1	0.4	39	4.8
Handicraft	3	0.9	2	1.9	0	0.0	1	0.4	6	0.7
Other business activity	6	1.9	6	5.8	12	8.4	68	26.9	92	11.2
Total	319	100	104	100	143	100	253	100	819	100

Source: Authors.

ICT use

	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
B2B e-commerce	210	65.8	19	18.3	43	30.1	64	25.3	336	41.0
B2C e-commerce	163	51.1	14	13.5	18	12.6	56	22.1	251	30.6
Electronic Data Interchange (EDI)	167	52.4	46	44.2	24	16.8	37	4.6	274	33.5
Supply Chain Management (SCM)	82	25.7	31	29.8	22	15.4	84	33.2	219	26.7
Enterprise Resources Planning (ERP)	154	48.3	22	21.2	31	21.7	69	27.3	276	33.7
Groupware	82	25.7	12	11.5	12	8.4	7	2.8	113	13.8
CAD/CAM	154	48.3	22	21.2	57	39.9	63	24.9	296	36.1
Intra-Social Networking Services (SNS)	43	13.5	14	13.5	14	9.8	29	11.5	100	12.2
Public SNS	62	19.4	3	2.9	6	4.2	7	2.8	78	9.3

Note: *multiple answers.

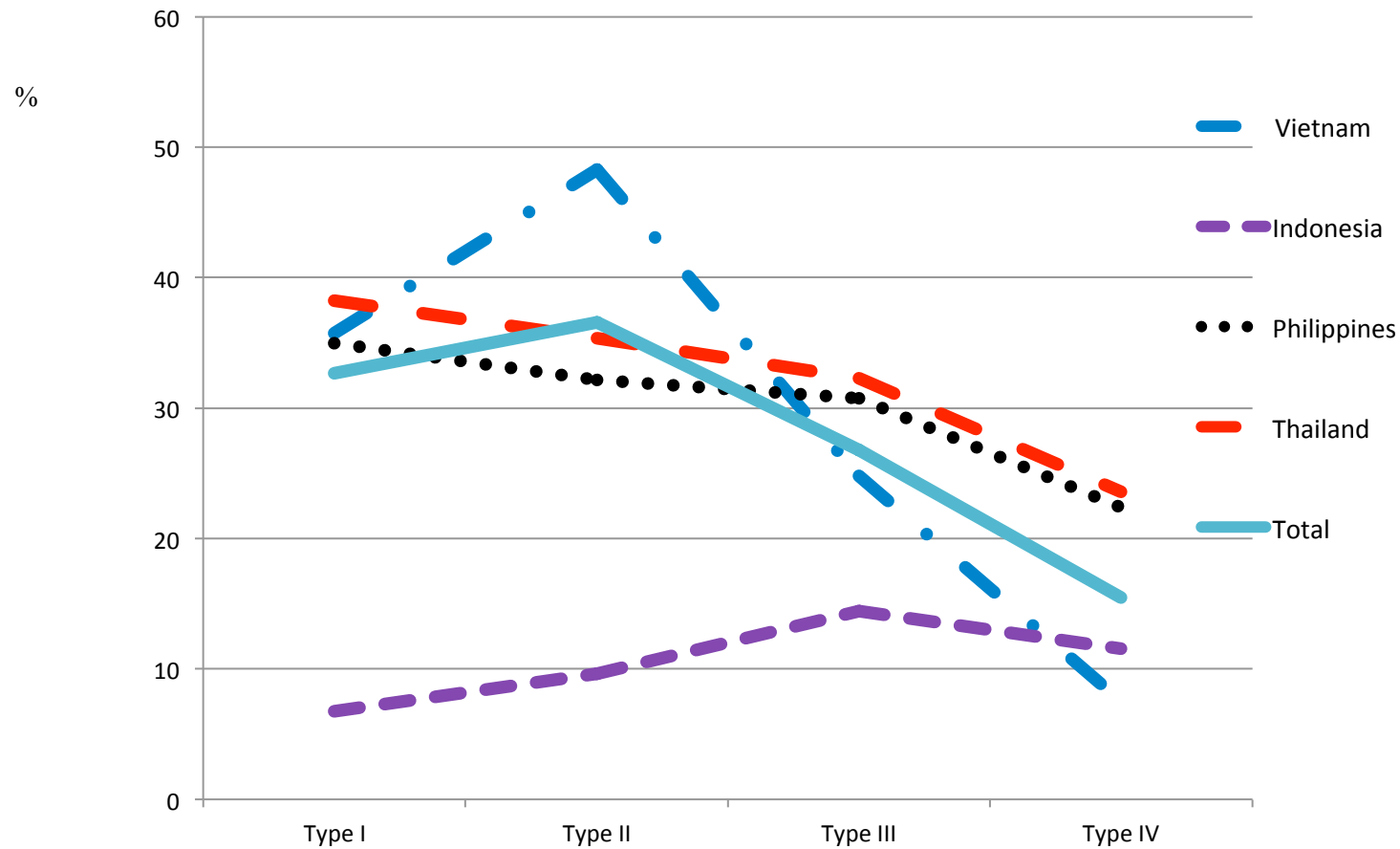
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Product innovation

		Vietnam		Indonesia		Philippines		Thailand		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Redesigning packaging or significantly changing appearance design	Achieved	114	35.7	7	6.7	50	35	96	37.9	267	32.6
	Tried	36	11.3	37	35.6	13	9.1	53	20.9	139	17
	Not tried yet	169	53	60	57.7	80	55.9	104	41.1	413	50.4
	Total	319	100	104	100	143	100	253	100	819	100
Introduced a new product, significantly improving existing products	Achieved	154	48.3	10	9.6	46	32.2	89	35.2	299	36.5
	Tried	25	7.8	39	37.5	21	14.7	62	24.5	147	17.9
	Not tried yet	140	43.9	55	52.9	76	53.1	102	40.3	373	45.5
	Total	319	100	104	100	143	100	253	100	819	100
Development of a totally new product based on the “existing” technologies	Achieved	79	24.8	15	14.4	44	30.8	82	32.5	220	26.9
	Tried	30	9.4	34	32.7	17	11.9	64	25.4	145	17.7
	Not tried yet	210	65.8	55	52.9	82	57.3	106	42.1	453	55.4
	Total	319	100	104	100	143	100	252	100	818	100
New product based on new technologies	Achieved	24	7.5	12	11.5	32	22.4	58	23.3	126	15.5
	Tried	70	21.9	25	24	19	13.3	75	30.1	189	23.2
	Not tried yet	225	70.5	67	64.4	92	64.3	116	46.6	500	61.3
	Total	319	100	104	100	143	100	249	100	815	100

Source: Authors.

Product innovation



- Type I Redesigning packaging or significantly changing appearance design
- Type II Significantly improving existing products
- Type III New product based on the existing technologies
- Type IV New product based on new technologies

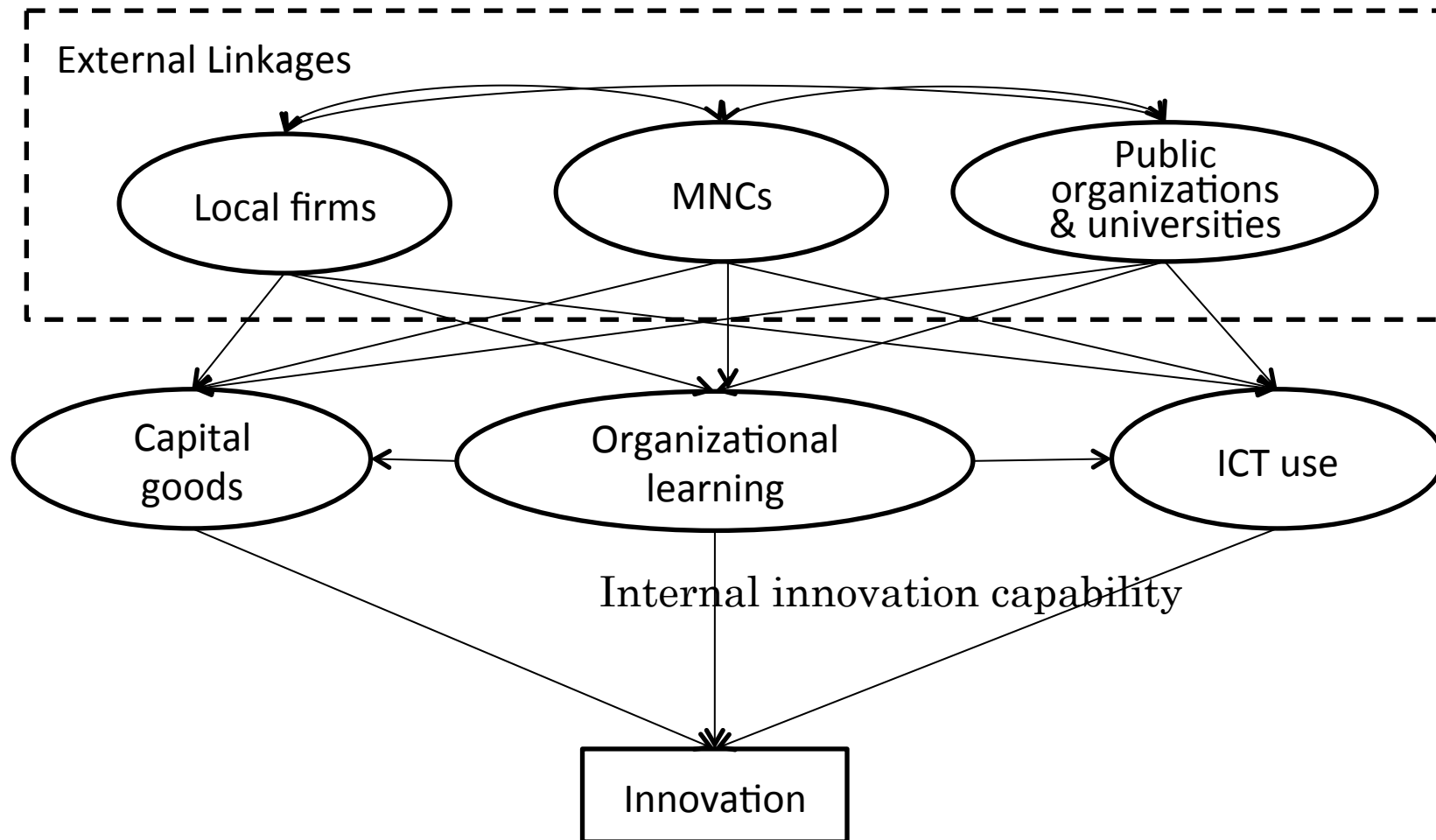
Process innovation

	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Decreased production of defective products	252	79.0	93	89.4	108	75.5	190	77.9	643	79.4
Reduced raw materials and energy usage	269	84.3	52	50.0	72	50.3	147	60.5	540	66.7
Reduced labor input (man-hour)	203	63.6	40	38.5	70	49.0	89	36.5	402	49.6
Secured a new source of intermediate goods	152	47.6	60	57.7	83	58.0	142	59.9	437	54.4
Substituted subcontract of intermediate goods for self-manufacture	191	59.9	37	35.6	46	32.2	103	43.5	377	46.9
Reduced delivery delay	207	64.9	96	92.3	123	86.0	209	85.7	635	78.4
Reduced prices of your main products	139	43.6	27	26.0	68	47.6	106	43.4	340	42.0
Reduced variation in product quality.	249	78.1	48	46.2	76	53.1	200	82.0	573	70.7

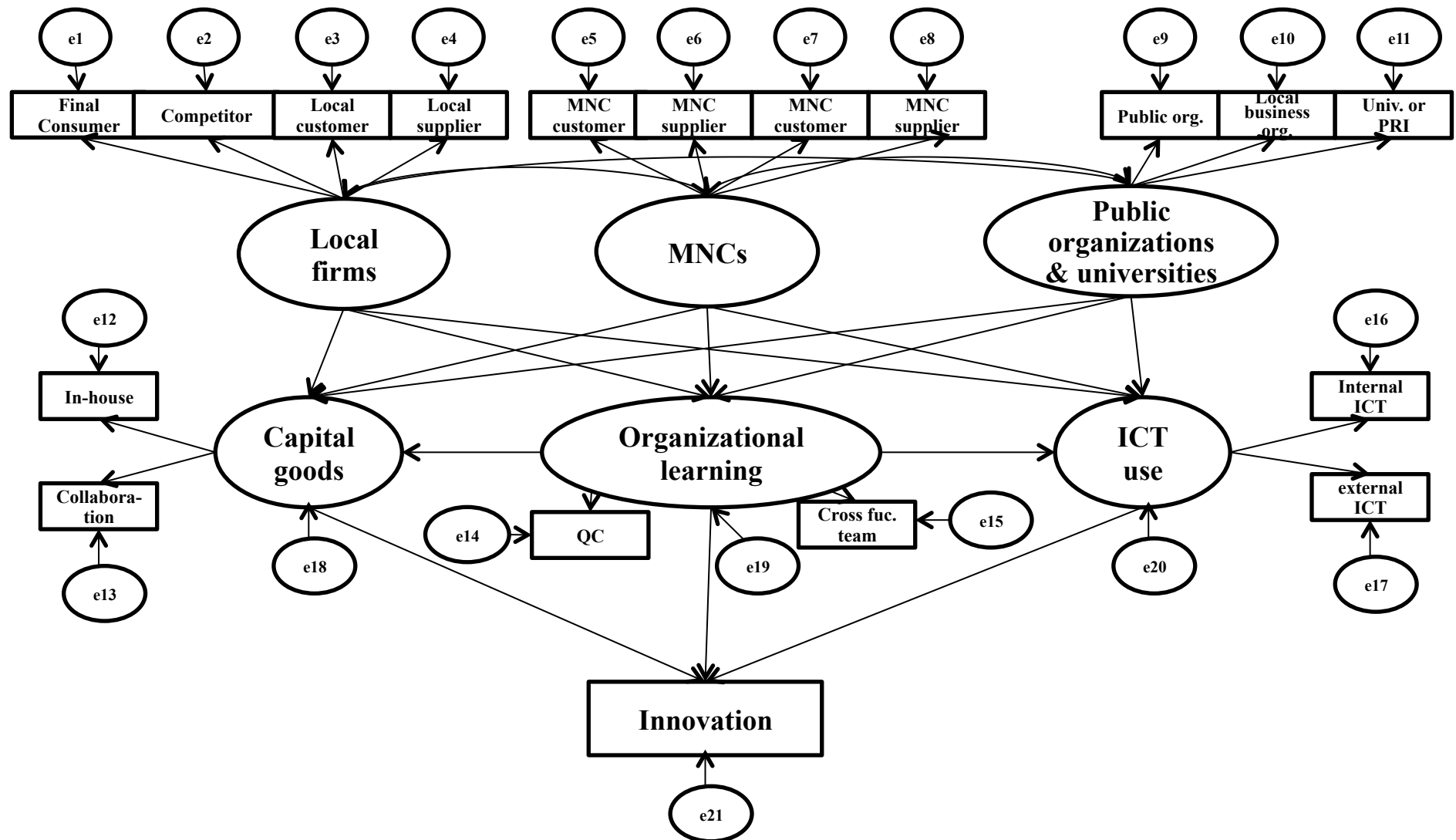
Note: *multiple answers.

Source: Authors.

Simplified path diagram



Detailed path diagram



Result of SEM: Fitness of the model

Fitness of model (Product innovation)

χ^2 value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
882.063	318	0	0.944	0.909	0.939	0.033	1272.06

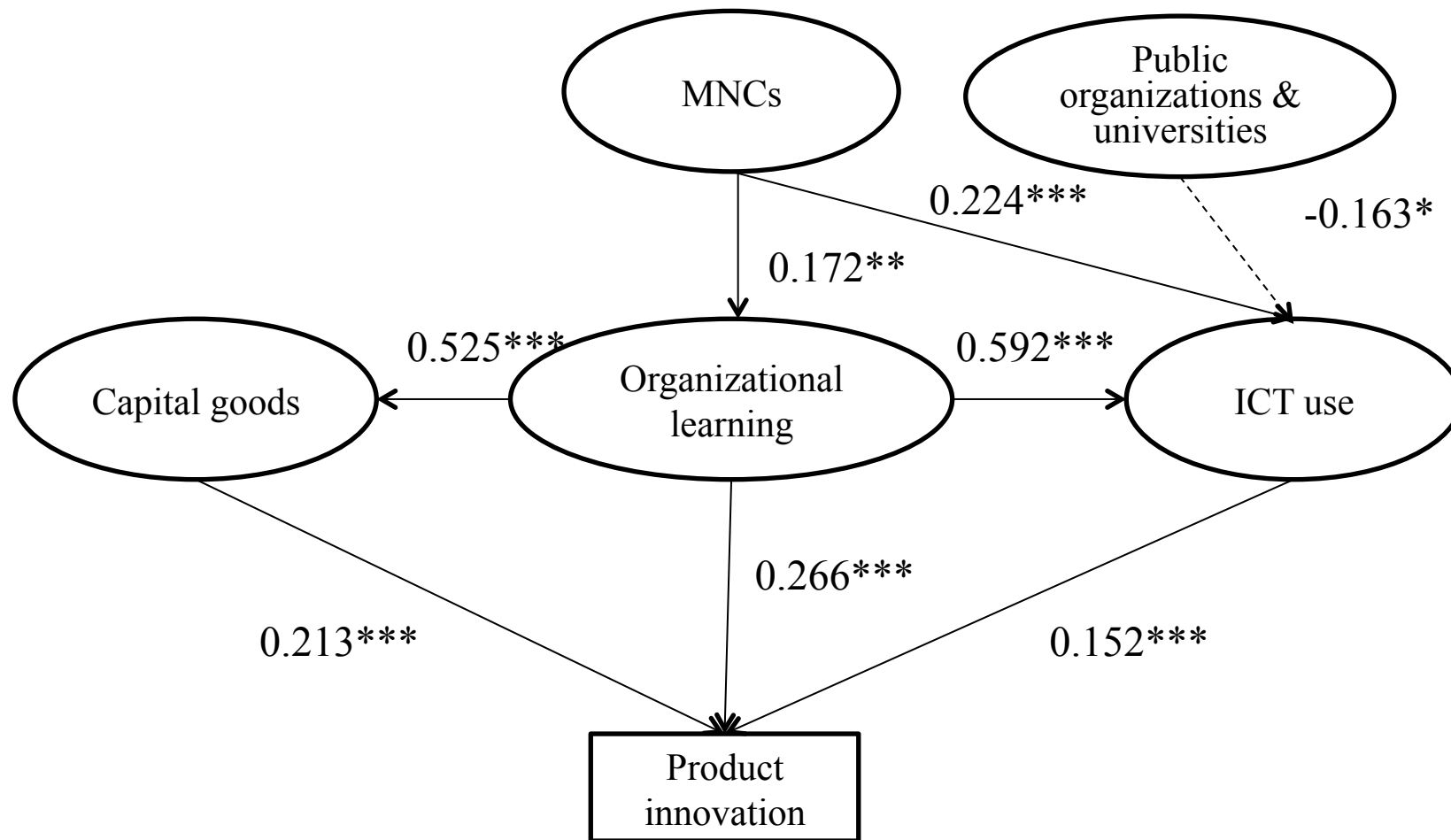
>=0.90 >=0.90 >=0.90 <=0.05

Fitness of model (Process innovation)

χ^2 value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
811.905	303	0	0.949	0.913	0.946	0.032	1231.91

>=0.90 >=0.90 >=0.90 <=0.05

Result of SEM: Product innovation



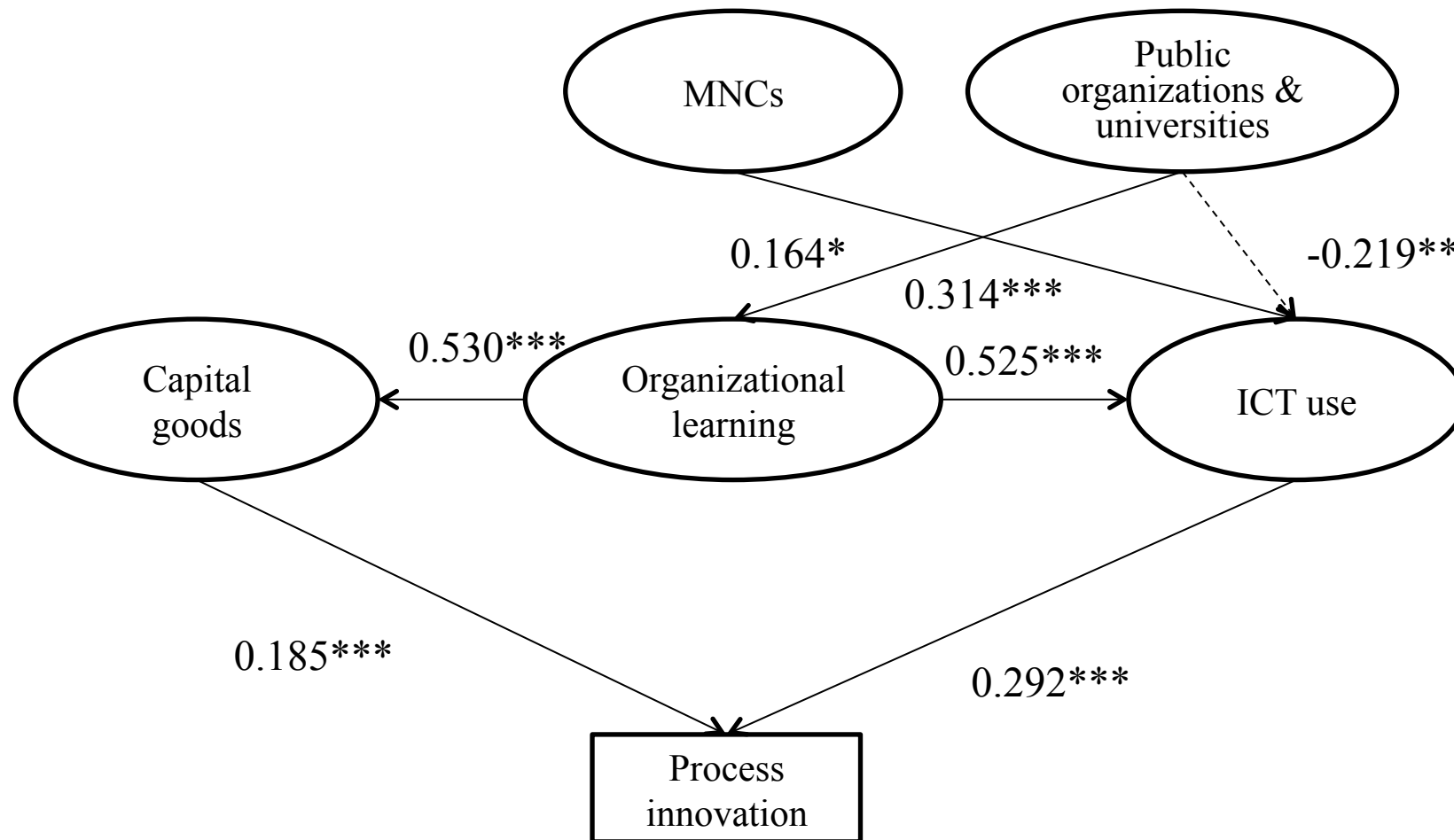
Results I

- (i) MNCs promote Organization learning and ICT use
- (ii) Organization learning enhances Capital goods as well as ICT use
- (iii) Organization learning, Capital goods, and ICT use enhance product innovation.

Discussions I

- Product innovation
 - It can be explained by all latent variables except the path from “MNCs” to “capital goods.”
 - The hypotheses have been demonstrated.

Result of SEM: Process innovation



Results II

- (i) MNCs promote ICT use
- (ii) Public organizations and universities enhance organization learning and Capital goods, but they provide a negative effect for ICT use
- (iii) Organization learning promotes Capital goods and ICT use
- (iv) Capital goods and ICT use promote process innovation.

Discussions II

- Process innovation
 - The path from “organizational learning” to process innovation becomes not significant.
 - However it can be said that “organizational learning” indirectly promote process innovation via capital goods and ICT use.
 - “Public organizations & universities” affects “organizational learning” significantly.
 - The path from “public organizations & universities” to ICT use is negatively significant.
 - The path from “MNCs” to “organizational learning” becomes not significant.
 - However “MNCs” promote ICT use such as the global supply chain and the Internet.

Conclusions I

- This study examines innovation activity in four countries in ASEAN based on mail/phone surveys of ERIA.
- In order to examine their potential, basic research on **their internal innovation capability, external linkages to promote innovation**, or how they are integrated into the global supply chain constructed by MNCs, for example, is required.
- For this purposes, a rigorous statistical method such as SEM should be employed to obtain the correct results.

Conclusion II

- We postulate the theory that external linkages promote internal capability and finally enhance innovation.
- The results obtained indicate that MNCs affect organization learning, which enhances capital goods and ICT use, and then all these three factors that construct internal capability can also promote product innovation.

Remarks

- The limitations in this study are the same as the limitations of SEM.
- SEM is a good tool to examine a hypothesis, but it is not necessarily good at finding the reasons for issues or establishing a policy to solve them.
- We need to combine various research methods by further analysis.

Acknowledgement

- The first author received the financial support from the Japan Society for the Promotion of Science (c-24530435), which is gratefully acknowledged.