DOES THE PRESENCE OF THE FOREIGN FIRMS IMPROVE TECHNOLOGICAL CAPABILITIES OF THE LOCAL FIRMS?: CASE STUDY OF THE INDONESIAN AUTOMOTIVE SECTOR

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TRACK: TECHNOLOGY ADOPTION

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ABSTRACT

FDI inflows was expected to bring much needed capital, new machines, new technologies and sciences, marketing techniques and management skills which increase the productivity and competitiveness of the domestic industry. This paper seeks to examine how Indonesian local automotive firms' technological capabilities have evolved vis-à-vis foreign firms following increased liberalization from the late 1990s. The evidence amassed shows that there were no obvious statistical differences in human resource and process technology capabilities between foreign and local firms in 2006. Although foreign firms enjoyed superior product technologies with access to their subsidiaries, local firms have invested more in R&D technology to compete with them. Foreign firms enjoyed higher export intensities and export experience than local firms, which seems to be a consequence of regional production networks established by foreign multinational assemblers in Southeast Asia. The results confirm that the liberalization experience has driven rather than discouraged stronger initiatives in local firms to raise technological capabilities, though, foreign firms still enjoy higher export-intensities. However, various policies must be taken by Indonesian Government, especially for foreign firms, so they will be imposed to improve significantly their technological capabilities which expected giving multiplier effect such as technology spill over to the local firms.

Keywords: Technological capabilities, foreign ownership, export, automotives, Indonesia

INTRODUCTION

The Development of Automotive Industries in Indonesia was started when the Ministry of Industry and the Ministry of Trade launched the decree to introduce the important of vehicles, both completely built up (CBU) and Completely Knock Down in 1971. Since that period, the Indonesian automotive industries have experienced fluctuated progress.

However, since 1998, the role of Indonesian Automotive in Indonesia economics development has been increasing significantly. In 2006, the automotive industries absorbed 72,382 employees. The annual growth of employment of the industries in period 1998-2006 has attained 4.6 per cent annual growth which was better than 1.7 per cent of its manufacture's annual growth. (GAIKINDO, 2007)

In terms of productivity, the Indonesia automotive has also succeeded achieving well productivity performance. In 2006, the average of value added per worker of industries reached 600 millions rupiahs which is 6 times greater than the average of Indonesian industries in that period. (GAIKINDO, 2007)

In 2006, the export of the industries has reached US $ 2,431.7 millions. In period 1998-2006, its annual export growth exceeded 11.7 per cent which was greater than 8.8 per cent of its manufacture export growth. (BPS, 2007)

Apart from the increasing export, the import also has been increasing since last period. The import of automotive sector has also increased from US$2,157.7 millions in 2000 to US $ 2,906.9 millions in 2006. The import annual growth rate reached 5.1 per cent in that period. The total balance for the automotive industries has been always negative. (BPS, 2007)

The development of Indonesian automotive industry was contributed mostly by multinational company through the foreign direct Investment. There are only a few firms which fully owned by local. (GAIKINDO, 2007). Actually, The Indonesian automotive industries has been enjoying FDI inflows since the beginning 70s, when the Ministry of Industry and the Ministry of Trade launched the decree to introduce the important of vehicles, both completely built up (CBU) and Completely Knock Down. The decree was demanding the foreign firms to invest for local assembly and manufacture facilities, by providing lower tariff rates for semi-knockdown (SKD) and completely knocked down (CKD) kits as compared to completely built up units (CBU).

Many transition economies offered some incentives for foreign company to invest in the countries such as tax reduction, easy land ownership, investment procedure etc. and domestic market access, cheap labour. FDI inflows was expected bringing much needed capital, new machines, new technologies and sciences, marketing techniques and management skills as it can increasing the productivity and competitiveness of the domestic industry as well as their subsidiary company. Extensive work on multinationals have since flooded to academic world. It can be traced to Lall (1979, 1994), Dunning (1971, 1994) and Narula and Dunning (2000), Lall and Narula (2004) and Rasiah (2004). Yet, there is no clear evidence whether the foreign investment can improve the productivity and competitiveness of that positive by conducting transfers technology to domestic firm or they are only taking the benefit from government's incentives.

The presence of multi national company through foreign direct investment has already proven given significant contribution to the development of Indonesian automotive industry. However it is not clear whether technology transfer resulting from FDI will go beyond actual projects undertaken by foreign investors, and through knowledge spill over will benefit local firms has been occurring..

The presence of spill over technology from foreign firm to local firms is hard to be identified. Caves (1974) had initiated the model to examine spillover effects by adapting the growth accounting model originally advanced by Solow (1956) arguing that it generates demonstration and competition effects on local firms. Empirical works using refinements of this model produced mixed result (e.g Blomstorm, 1986; Blomstorm and Sjolholm, 1999, Aitken and Harrison, 1999; Sjolholm, 1999). However, Lall (1992 and Rasiah (1995) have argued that spillovers being external to firms cannot be measured exhaustively. Besides, spillovers has both pecuniary and non-pecuniary, and positive and negative dimension so that empirical investigation can never be carried out exhaustively (Rasiah, 1995)

There has, however, been one consistent finding by neoclassical analysts, i.e. technology gap inversely correlated with spillovers from foreign to local firms (Rasiah, 2009). The rationale is that the lower the technological gap the easier is the diffusion from foreign to local firms.

In addition to addressing the embodied nature of technical progress, the issue of institutions and institutional coordination is critical in simulating learning and innovation in firms (Nelson, 1994). Using the experience of Japan, Freeman (1989) demonstrated convincingly that international flows of stocks of knowledge from developed to developing countries take a sequential shifts involving import, adaptation, assimilation and innovation. Dosi (1982) and Pavitt (1984) advanced the importance trajectories and taxonomies in technology development. Disentangling further processes of learning and innovation –following the conceptual exposition of Lall (1992), Figueiredo (2002) and Arifin and Figueiredo (2004) and Rasiah (2004) showed how firms moved up the technology trajectory by learning initially simple and later complex technological capabilities before eventually participating in R&D activities. Therefore in this paper, model framework which is relies on embodied technical progress using related proxies to compare and examine technological capabilities, human resources, process technology and R&D capabilities. Given that spillovers are external firms and are not measurable exhaustly, the measurement of capabilities allows estimation of potential rather than actual spillovers that can take at host sites (Rajah 2004, 2009)

Drawing on sample of 93 automotive firms in Indonesia, the paper seeks to examine: (1) differences in support for the development of industry from industrial cluster development approach namely basic infrastructure support, high tech infrastructure support, network cohesion support and global networking support, between foreign and local firms (2) The differences in economic performance of the firms, namely export percentage and other critical variables namely age and size of the firms between foreign and local firms. (3) The differences in firms level technological capabilities and its components such as human resources capabilities, research and development capabilities and process capabilities between foreign and local firms. (4) Statistical relationship involving technological capabilities, infrastructure support, export performance and other critical variables for all firms, and also for foreign and local firms respectively. Our paper is organized as follows. In the following section we provide of the reviews of literature which supported the research and overview of the Indonesian automotive sector. Section 3 presents methodology and data. Section 4 examines the statistical differences between foreign and local firms from technological capabilities and its components. And this section also tries to explain the differences of the economic performances of the foreign firms as well as local firms. Eventually in this section, the correlation between technological capabilities, industrial development support, economic performances and other critical variables are examined. Section 5 presents the conclusion.

LITERATURE REVIEW

Technological Capabilities

Rosenberg and Firschtak (1985) defined technological capability as a process of accumulating technical knowledge or a process of organizational learning. Technological capability enable the enterprises to undertake a range of productive task, extending from pre-investment analysis to product and process engineering, manufacturing and the introduction of a new technologies as they appears. Technological capability can be assessed in terms of a firm's ability to (i) identify its technological needs and to select the technology to fulfill the need; (ii) Operate, maintain, modify and improve the selected technology; and (iii) promote technological learning. Similarly, Baranson and Roark (1985) described that technological capabilities can be distinguished in operational, duplicative and innovative capabilities.

Bell (1987) grouped technology flows into three categories; Flow A consists of capital goods and technological, engineering and management services; Flow B consists of the skills and know-how to operate and maintain the newly established production technology; and Flow C consists of the knowledge and expertise for implementing technical change, or the know-why. In this framework, Flow A leads to improvement in production capability, Flow B contributes to technological capabilities at the basic, routine level, and Flow C enables the firm to generate dynamic technical and organizational changes. On the other hand, for implication reason, Lall and Siddhartan (1982) outlined a functional categorization of technological capabilities based on the task facing a manufacturing firm. The task and associated capabilities are characterized into two groups: investment capabilities and production capabilities. These are further divided into three levels. The first level is simple and experienced based, the intermediate level is adaptive and duplicative in nature but is research based, and the advanced level is innovative and risky but is also research based.

Wei (1995) integrated Lall's functional categories with the Bell's technologies flow classification. He concluded that (i) not all technology flows generate technological capability, and (ii) linkages with local supplier and other groups within the local economy are critical for enhancing the capabilities. Biggs, Shah and Srivastava (1988) also added that the most critical element of technological capability is the set of learning mechanisms available to acquire new or improve existing Investment and production capabilities.

Simplifying the model, Ariffin (2000) reduced the number of functions and essentially abandoned the 'stages' dimension. Dutrenit (2000) also simplified the framework further in order to highlight the key concept of the 'Transition' in capability building between (a) the Lall-type progression through levels of capability to create a basic minimum capability for significant innovation to (ii) the process of creating strategic capabilities in successive fields of core competence - as in the literature examining strategic management in advanced country firms).

Figueiredo (2001) took the opposite direction and elaborated in greater detail on the framework. He developed a fine-grained analysis of changes in the capabilities of two Brazilian steel firms in order to examine the relationship between (a) the firms' progress through different capability levels over 40 years and (b) their approaches to managing the acquisition and absorption of technology.

Furthermore, Ariffin and Figueiredo (2006) tried to simplify the framework. They included only four functions and six liveries in Brazil and Malaysia. Subsequently, in a comparative analysis between industries in Brazil, Figueiredo (2007) further simplified the same basic the same framework – using just three functional categories and six levels of capability.

From different perspective, Lee, Bao and Choi (1988) advance a model with three levels of technology development: the lowest level, assimilation and improvement of mature technology; the intermediate levels, assimilation and improvement of new technology; and the highest level, generation of emerging technology.

Technological capability can be improved through modes technology transfer. International technology transfer research is extensive and varied in perspective, attracting many researches from cross-of disciplines including political sciences, economics, sociology, public policies, marketing and more recently management of technology (Cusumao and Elenkov, 1994).

A wide range of issues have been investigated including the technology transfer process itself, appropriateness of technology, cooperation and conflict between transfers countries, the success of technology transfer and the social benefits of technology transfer to both supplier and recipients countries. (Katz, 1985; Lall and Siddhartan, 1982; Lynn 1985; Mytelka, 1985)

Despite of the volume of research undertaken, much of the international technology transfer literature is fragmented along different specialities, and there is still no generally accepted paradigm (Reddy and Zhao, 1990; Wong, 1995). Thus, the concepts, variables and measures relevant to the study of technology transfer are likely to differ from one study to another (Kumar, V., Kumar U. and Persaud A., 1999).

Technologies are transferred through various modes, such as direct foreign investment, joint venture, license, turnkey projects, purchase of capital goods and technical agreement and cooperation (Dunning, 1981, Katz 1985). Within these broad modes of transfer, several transfers mechanism can be identified, for example, expert services, information services, workshop, seminars and exchange of researches (Dunning, 1981). The amount of technology transferred depends on the particular mode chosen (Contractor, 1985; Cusumano and Elenkov, 1994; Reddy and Zao, 1990). For example, less is transferred under technical agreement than through foreign direct investment or joint venture agreement.

Industrial Development Pillars

Industrial clusters, which Porter (2000) defines as "a geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities", have long attracted the attention of researchers and policy makers for the growth prospects.

Industrial clusters can make a potentially important contribution to development of industry. They can promote sustainable employment and incomes and thus better the situation for the working and also they enhance the ability of small firms to compete in global markets. Industrial cluster development has been developed by Porter namely Porter's Diamond. The essence of Porter's (2000) model of competitive advantage is the diamond, viz., one, factor conditions; two, firm strategy, structure and rivalry; three, demand conditions; and four, related and supporting industries. National competitive advantage is achieved when particular industries meet the four ingredients above. Because critical technologies (core competence) drive Porter's competitive clusters, specialization in particular goods and services are the drivers.

In contrast, Best (2001) provided different industrial cluster development model. Best provided idea three factors which drive the Industrial growth from the capabilities and innovation perspective, namely business model, production capability and skills formation. In addition Best argued that techno-diversity was a crucial element of dynamic cluster as it impulse the creation of new technology and new firms on one side, and differentiation and division of the labour on the other side.

Lall (2001) was to assert that economies that failed to develop their technological capabilities become losers in globalization process. Central to the failure of EPZs and industrial estates in developing economies has been the lack of development of an effective enabling environment for technological upgrading, differentiation and division of labour, and new firm and industry creation.

Enriching the above available industrial developmen models, Rasiah (1992) proposed quad system industrial development model. The model describes that four pillars which work simultaneously are needed to accelerate the industrial development, especially in developing countries.

A strong role by governments is the first central pillar of a dynamic cluster to provide stability (macroeconomic, political and security) and efficient basic infrastructure. The second is vital for the continuous evolution of technological capabilities in the cluster. It is the environment where the institutions coordinating learning and innovation evolve effectively to stimulate technology acquisition through learning by doing, licensing, adaptation, training, standards appraisal mechanisms, a strong intellectual property right framework to prevent moral hazard problems facing innovators and research and development.

The third requires that the cluster be globally connected - markets and value chains. Global markets provide the economies of scale and scope and the competitive pressure to innovate. Global value chains assist economic agents in the cluster to orientate their strategies to the critical dynamics that determine upgrading and value addition (see Gerrefi 2002; Gerrefi, Humphrey and Sturgeon 2005).

The fourth distinguishes a cohesively networked cluster from others defined by truncated operations. Lundvall (1988) expanded the elements of interdependence and interactiveness by articulating the role of producer-user relations in innovation. The nature of interface and coordination between vertically connected economic agents is vital in the horizontal evolution of innovation activities. Connectivity and coordination is critical for knowledge flows - beyond simply codified information that markets can coordinate. Intermediary organizations such as industry-government coordination councils and chambers of commerce play an important role to increase connectivity and coordination in dynamic clusters.

Economies that managed to strengthen the four pillars of the systemic quad have managed to sustain several decades of rapid growth and employment absorption, value addition and sustained exports (e.g. Singapore, Taiwan Province of China, Hong Kong, Ireland and Israel). On the other hand, economies that simply focused on providing basic infrastructure, political stability and security at least in EPZs and industrial estates have failed to enjoy sustained growth and employment absorption, value addition, sustained exports (e.g. Brazil, Indonesia and Philippines). Whereas sustained value addition, differentiation and division of labour, and wage increase has helped raise sharply standards of living human development in the successful economies.

The Development of Indonesian Automotive Sectors

One of Indonesia's oldest manufacturing activities is the automotive industry, dating back to the establishment in 1928 of a General Motors (GM) assembly plant in Tanjung Priuk, Jakarta. For the following 40 years, the industry experienced little sustaining growth, owing to the Great depression, war, the independence struggle and uncertain post independence business climate. Some attempts has been made to develop the industry as part of the 1950s Benteng industrialization program, but these were half hearted and amounted to little. (Aswicahyono, 2000).

By the late 1960, Hansen (1971) found the industry was small and technologically primitive. The annual market size was 10,000-15,000 units, far below the level needed to support just one plant of efficient size. The supplier base was extremely limited: There was no international quality stamping plant, foundries could not meet acceptable quality control standard, high-quality steel production was not available. There was no industrial paint work capacity, and very few electronic components were produced locally, including tyre and battery.

In 1971, The Minister of Industry and the Minister of Trade issued a joint ministerial decree to introduce the importation of vehicles, both completely-built-up (CBU) and completely-knocked-down (CKD). Also the decree included the regulation of the establishment of assembling plants and sole agents in the country. This decree has succeeded to increase assembly plants and supporting industries, such as those manufacturing tires, paint, and batteries. Local companies also have participated in this era by involving in designing jigs and fixtures and also supporting certain processes, like painting, welding, trimming, and metal finishing.

In 1976, the government issued a First Phase Deletion Program. The program was known as deletion program since the program asked the companies to delete some components from the imported components list. The companies were intended to produce local content for their own product. Simultaneously, the government applied high import duties to vehicles that did not use locally produced stamping parts. The government also prioritized the development of vans/minibuses by imposing higher taxes on sedans. Its has succeeded, general component plants blossomed and started to produce radiators, seats, exhaust pipes, shock absorbers, wheel discs, seats and interiors, wiring systems gaskets, plastic parts, chassis frames, stamping parts, rubber parts and jigs.

Following the first phase of deletion program, in 1983, the government issued the second part of the deletion program which imposed the companies to produce main component locally. The high import duties were then applied to imported main components. The program had succeeded to push the supporting industries started to produce main components, such as transmissions, clutches, power trains (including engines), brake systems, cast and forged parts, and windows regulators.

In 1993, the government replaced the Deletion Program with the Incentive Program, known as the 1993 Automotive Policy Package. Automobile manufacturers were allowed to choose the components that would use local products and were granted discounts on import duties. The Automotive could conduct local content self assessment. As they achieved higher percentage of local component, they enjoyed higher discount on import duties. The program succeeds to boost engine plants, transmission plants and propeller shaft plants grew. It had succeeded to fulfill domestic market as well as international market.

To accelerate the Incentive Program, in 1996, the government launched program which expected to speed up the and introduced the National Car Program. In order to get an exemption of import duties, companies had to reach 20 percent, 40 percent and 60 percent local content in the first, second, and third years of production. While massive monetary crisis was occurring in Asia regional in 1997, Indonesia suffered the worst. It caused many companies collapsed as their foreign debts more than quadrupled. Before the crisis, mostly the share's majority of Indonesian automotive company was owned by local investor. In order to expand the industries, the companies owed some money from various sources mainly from foreign institutions. During financial crisis, they offered their strategic partner to buy-out the credit replaced by the share. Since that period, the share's majority of the Indonesian automotive industry owned by foreign investment/parents companies has been increasing.

In 1999 Indonesian government issued Automotive Policy Package, which aimed to stimulating the export of automotive products, driving the post-crisis domestic market and strengthening the sector's structure by developing the parts manufacturing industry. The Incentive Program was removed and import duties were lowered by more than half on average. It caused the competition got tougher as local products had to compete with imported ones. This condition pushed the local producer to improve the quality and productivity of their production processes. In order to attract the development of the local industries, the government offered very low or zero duties for imported material for automotive components. The program had succeeded to increase the competitiveness of local automotive components producer.

METHODOLOGY AND DATA

The primary data were collected through a structured questionnaire survey of automotive firm in Indonesia. The survey was conducted in Jakarta, Bekasi, Karawang and Purwakarta. 93 firms have responded for the survey, submitting the fulfilled structured questionnaire which was designed to explore deeply the nature of the firms in the cluster. The area covers more than 79 per cent number of automotive industries, and also covers almost 90 per cent of the employment absorbent, production and exports of Indonesian automotive industries respectively (Gaikindo, 2006).

The research applies the quad system cluster development approach to explore the nature of Jakarta automotive clusters. Rajah (2004, 2007) has applied this approach to explain the nature of Electronics Industries in Penang, Johor Bahru, Batam. In addition, the research uses a methodology that measures technological capabilities assigning indexes normalized from related proxies. The use of indexes in examining the technological capability of firms can be traced to Lall (1992), Bell and Pavitt (1995), Westphal *et al.* (1990), Wignaraja (2002) and Rasiah (2004, 2007). Wignaraja adapted the Ernst *et al.* (1998) taxonomy of capabilities to fit the narrow range of data available to examine upgrading in Mauritius' firms.

The secondary data was collected from various institution either government institutions such as Ministry of Industry, Ministry of Trade and Statistic Center Agency or non government institutions namely GAIKINDO, GIAMM and HKI etc.

Specification of variables

The variables which are used in this paper can be shown in Table 1. The table also contains the components of variables, method of variables measurement and source of data. As mentioned above, the industrial development pillars were measured using data from questionnaire. For example, first pillar of industrial development namely basic infrastructure was measured by averaging the respond of the firm concerning the quality, availability and delivery of transportation facilities, power, water, telecommunication, health service, basic government service, access to capital, primary school and training institution. More detail can bee seen in table 1.

On the other hand, the research recognizes technological capabilities of the firms as a source of firm level competitiveness, and subsequently technological capabilities were computed by estimating the strength or value of human resource, process technology and R&D activities.

Table 1. Variables, proxies, Acronym, and measure

Variables and proxies	Acronym	Measures
Basic Infrastructure	BI	1/9[$TRANS_i$, $POWER_i$, $WATER_i$, $TELCOMM_i$, $HEALTH_i$, $BASICGOV_i$, $CAPTLACCES_i$, $PRIMARYSCHO_i$, $TRAININST_i$]
High Technology Infrastructure	HTI	1/9[$UNIVEDU_i$ $RDSCIENT_i$, $RDINCENT_i$, $RDGRANT_i$, $RDINST_i$, $TESTFAC_i$, IPR_i, ICT_i,$VENCAP_i$].
Network Cohesion	NC	1/11 [$RDREL_i$, $FINANREL_i$, $DISTREL_i$, $SUPPLREL_i$, $CUSTREL_i$, $TECHREL_i$, $BUSSREL_i$, $ASSOCREL_i$, $ALLIANREL_i$, $LABORGREL_i$,$ENVORGREL_i$]
Global Networking	GN	¼ *{$ALLIACT_i$, $JITINV_i$, $MRKTRES_i$, $OVSEAPROM_i$]
Technological Capabilities	TC	$HR_i + PPT_i + RD_i$.
Human resource capabilities	HR_i	1/3 [TM,TE,CHR]
Process and Product Technology capabilities	PPT_i	½[Procadv,Prodadv]
Research Development capabilities	RD_i.	½[RDexp,RDemp]
Training Mode	TM	[training institution type]
Training Expense	TE	% in payroll
Cutting edge HR practices	CHR	(incidence small group activities, qcc, stock sharing, performance-based rewards and promotion)
Process advancement	PROCadv	1/3[Procadv, IQCS, Upgraded]
Product advancement	PRODadv	½[Prodlifetime+NewProd]
RD expenditures	RDexp	RD exp/Total exp
RD employment	RDemp	RD emp/Total emp
Export Percentage	ExPerct	Export Sales/Total Sales
Firm's Operation Period	Age	Operation period
Firm's size	Size	Employee > 500 ➔ Big ➔ Size=1; Otherwise Size = 0

The Industrial Development pillars

Basic infrastructure

Basic infrastructure was expected to show a positive relationship with economic performance. BI was calculated using the formula:

BI_i=1/9[$TRANS_i$, $POWER_i$, $WATER_i$, $TELCOMM_i$, $HEALTH_i$, $BASICGOV_i$, $CAPTLACCES_i$, $PRIMARYSCHO_i$,$TRAININST_i$]. (1)

The proxies were normalized using the following formula :

$$\text{Normalization score} = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad (2)$$

X_i, X_{min} and X_{max} refer to the ith, minimum and maximum values of the proxy. Caution must be taken when extreme data appear as result of survey. Also, it sould be aware while interpreting the normalized data since that procedure generate the highest observation of each proxy to one, and lowest one to zero.

High Tech Infrastructure

High technology infrastructure was expected to show a positive relationship with economic performance. HTI was calculated using the formula:

$HTI = 1/9[UNIVEDU_i\ RDSCIENT_i, RDINCENT_i, RDGRANT_i, RDINST_i, TESTFAC_i, IPR_i, ICT_i, VENCAP_i]$. (3)

Network Cohesion.

Network Cohesion was expected to show a positive relationship with economic performance. NC was calculated using the formula:

$NC = 1/11\ [RDREL_i, FINANREL_i, DISTREL_i, SUPPLREL_i, CUSTREL_i, TECHREL_i, BUSSREL_i, ASSOCREL_i, ALLIANREL_i, LABORGREL_i, ENVORGREL_i]$ (4)

Global Networking.

Global Network was expected to show a positive relationship with economic performance. GN was calculated using the formula:

$GN = ¼ * \{ALLIACT_i, JITINV_i, MRKTRES_i, OVSEAPROM_i]$ (5)

Firm Level Technological capabilities

The overall Technological Capabilities (TC) was measured by averaging the variables of HR (technology embodied in humans), PPT (technology embodied in machinery and equipment and intangible processes) and RD (technology development focus embodied in products, processes and humans). TC was measured as:

$$TC = HR_i + PPT_i + RD_i. \quad (6)$$

The use of TC will help in the estimation of differences in overall technological cpabilities between foreign and local firms, and in establishing its impact on export incidence. TC is expected to show strong and positive relationship with export percentage, exprt incidence and log productivity.

Human Resource capability.
Human Resource (HR) capability was measured as:

$$HRi = 1/3[TMi, TEi, CHRi] \quad (7)$$

Process capability.
Data on three proxies facilitated the computation of PT, which was calculated using the formula:

$$PT = 1/3[EMi, ITCi, QCi] \quad (8)$$

R&D capability

The learning process leads firms to eventually participate in new product development. While beginners mostly learn and absorb, more established firms typically learn and develop new products. With the exception of funding of public labs and universities, firms seldom participate in basic research. Hence, firm-level R&D is largely focused on process technology and product development – especially diversification of use and proliferation. Given its underdeveloped institutional and systemic facilities and the preponderance of labour-intensive assembly and processing operations, R&D is unlikely to produce statistically meaningful results involving exports and human resource. The data collected enabled the computation of two R&D proxies, viz., R&D expenditure as a percentage of sales and R&D personnel as a share of employment. Because of the inability to differentiate R&D personnel involved between product and process technology, this proxy was measured to relate to both product and process R&D and was measured as:

$$RDi = 1/2[Rdexpi, Rdempi] \quad (9)$$

where RDexp and RDemp refer to percentage share of R&D expenditure as a share of sales and R&D personnel in the workforce, respectively, of firm i.

Economic Performance

Export percentage was used to represent the economic performance indicators. The export percentage represents the ability of the firm to compete in global market.

Exported percentage was measured by following formula

$$Experct = \frac{Exportsales}{TotalSales} \quad (10)$$

Other critical firm level variables

Age

Firm which has longer experience in operating the facilities were considered enjoy longer experience and tacit knowledge.

Ai = years in operation of firm i, = (2006-year of establish of firm i) (11)

Size

As economist recognizes the minimum scale economic, some scholars convinced that the larger number of employee, the better, the performance of the firm. In this paper, size of the firms was used.

EMP_i = number of employee of firm i (12)

Statistical Model

This section introduces the two statistical exercises carried out in the paper, *viz*., two tail t-tests to examine simple differences in means, and tobit regressions to evaluate differences after controlling for explanatory and other variables. Tobit regressions were preferred over ordinary least squares (OLS) regressions because the dependent technological capability variables are censored on the right and the left side of the data sets so that they take a minimum possible value of zero and a maximum possible value of one.

$$TC = \alpha + \beta_1 BI + \beta_2 HTI + \beta_3 NC + \beta_4 GN + \beta_5 XPERCT + \beta_6 SIZE + \beta_7 AGE + \mu \quad (13)$$

$$HR = \alpha + \beta_1 BI + \beta_2 HTI + \beta_3 NC + \beta_4 GN + \beta_5 XPERCT + \beta_6 SIZE + \beta_7 AGE + \mu \quad (14)$$

$$RD = \alpha + \beta_1 BI + \beta_2 HTI + \beta_3 NC + \beta_4 GN + \beta_5 XPERCT + \beta_6 SIZE + \beta_7 AGE + \mu \quad (15)$$

$$PPT = \alpha + \beta_1 BI + \beta_2 HTI + \beta_3 NC + \beta_4 GN + \beta_5 XPERCT + \beta_6 SIZE + \beta_7 AGE + \mu \quad (16$$

STATISTICAL ANALYSIS

The statistical results are examined by three categories, *viz.*, descriptive, two-tail differences in means and tobit regressions controlling for other effects. The analysis in sub-sections 1 and 2 go deeper to examine the components of HR, PT and RD.

Descriptive statistics

The results of the univariate tests of means and standard deviation by ownership are shown in Table 2. Foreign firms show significantly higher Export percentage, high tech infrastructure, network cohesion and global networking and X/Y and RDP means than local firms. There are no obvious differences in the RD and PT means, and only a marginally older operation period mean enjoyed by local firms over foreign firms.

Table 2 Descriptive statistics, industrial development pillars, technological capabilities, economic performance and other critical variables, Automotive firms in Indonesia , 2006

Variables	Local				Foreign			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Basic Infrastructure	1.89	2.78	2.3111	.24816	1.89	2.89	2.4119	.26245
Hightech Infrastructure	1.56	2.67	2.1556	.19656	1.78	2.78	2.2854	.16665
Global Networking	.00	.83	.4405	.21587	.33	1.00	.6731	.13627
Network Cohesion	2.68	3.22	2.9596	.11520	2.75	3.47	3.0064	.15855
Human Resources Capabilities Index	.11	.79	.3492	.15629	.11	.82	.4346	.18863
Research and Development Capabilities Index	.06	.70	.3113	.17146	.00	1.00	.3568	.25267
Process Capabilities Index	.19	.82	.4405	.15673	.00	.83	.4205	.19093
Technological Capabilities Index	.21	.65	.3670	.12088	.17	.79	.4040	.16895
Export Percentage	0	58.79	13.44	18.17	0	88	23.82	18.89
Empolyee Number	40	1976	525.97	457.72	59	5938	894.76	1218
Age	4	36	19.94	9.207	2	35	18.914	9.598
N			35				58	

Source:Authors Survey (2006)

Note: Likert scale score of firms (0-5 with from none to highest possible rating);

** and ** - statistically significant at 1% and 5% respectively.*

Statistical Differences

Foreign firms largely enjoyed significant better high-tech infrastructure and global networking. They also benefited slightly better network cohesion, as it was only statistically significant at 5 percent level (see Table 3). Most of the foreign firms are located in various established industrial cluster and they are also the subsidiary firms of the big multinational companies, therefore they enjoyed better high-tech infrastructure and global networking. Interaction with other firms through producer-user or seller-buyer interface as impact of regional production network caused the benefited better network cohesion.

In terms of Technological capability indexes, the foreign firms present slightly better performance on Human resource Capability Index. Experiencing better human cutting edge activities, training institution of the subsidiaries firm in various locations around the world offered its better performance.

The export incidence difference between foreign and local firms was statistically highly significant. Almost all foreign firms enjoyed export experience by benefiting from production networks with assembly firms. The mean export intensity of foreign firms of 23.8 percent was significantly higher than the 13.44 percent of local firms. Interviews show that Korean and American assemblers have adopted the typical Japanese practice of specializing on particular components, CKDs and CBUs and then engaging in regional trade across Southeast Asia.

Table 3 Statistic's Differentiation involving industrial development pillars, technological capabilities, economic performance and other critical variables, Automotive firms in Indonesia , 2006

Variables	Firms		t
	Local	Foreign	
Basic Infrastructure	2.3111	2.3774	-0.867
High-Tech Infrastructure	2.1556	2.2854	-3.401*
Global Networking	.4405	.6731	-6.379*
Network Cohesion	3.4519	3.561	-2.646**
Human Resources Capabilities Index	.3492	.4346	-2.251**
Research and Development Capabilities Index	.3113	.3568	-.940
Process Capabilities Index	.4405	.4205	.521
Technological Capabilities Index	.3670	.4040	-1.130
Export Percentage	.13441	.238244	-2.605*
Age	19.9429	18.9138	0.509
Employee's number	525.9714	894.7586	-1.717
N	35	58	

Source:Authors Survey (2006)

Note: Likert scale score of firms (0-5 with from none to highest possible rating);

** and ** - statistically significant at 1% and 5% respectively.*

Statistical Analysis

This sub-section examines ownership-based statistical differences in technological capabilities after controlling for size and age. The results of the tobit regressions passed the model fit (X^2) test.

The results confirm that there are no obvious differences in RD and PT activities between foreign and local firms (see Table 4). However, there are ownership-based differences in RD activities. Although the coefficient of FO is marginal it is statistically highly significant. Interviews show that local firms invest more than their foreign competitors located in Indonesia to compete. Foreign firms continue to enjoy significant technological support from their subsidiaries abroad.

Global Networking has proven present significant influence on HR, PT and TC. On the contrary there is no influence of the global networking on the RD. The result implies that the presence of regional production network especially in ASEAN countries as an implication FTA has bear the influence of global networking on HR, PT and TC. From other perspective, even though the inter-linkage between the firms in ASEAN countries becoming stronger, R&D activities were still conducted in the parents countries.

Quite similar with the global networking, the network cohesion has also presented significant impact on the HR, PT and TC. Different with the Global networking, network cohesion has provided slightly impact on RD Development. Similar reason for the presence of the impact on the HR,PT and TC can be derived for global networking. But interaction between local firms and local firms, directly or indirectly has hold up the RD activities in the firms.

The results also confirm that there is slightly positive effect of export-orientation in improving the TC either in local or foreign firm. Furthermore, export orientation has significant impact on TC for all firms. Similarly, export orientation has significant impact on HR and RD for all firms. Interestingly, the impact of orientation only has significant impact on PT for local firms only It implies that export orientation has succeeded to impose the Indonesia automotive firm to improve their technological capability as involving in international market required advanced technological capability to maintain the competitiveness. Deregulation in Indonesia since particularly 2000 has also driven and supported automotive firms to acquire involve in international market.

The control variable of Size was significant in the HR, as economist recognizes the minimum scale economics, some scholars convinced that the larger number of employee, the easier to improve the HR. On the other hand, the critical variable of Age was significant in the PT. Firm which has longer experience in operating the facilities were considered enjoy longer experience and tacit knowledge.

Table 4 Statistical relationship involving Industrial development pillars, technological capability and other critical variables

	Human Resources Cap.			Research Development Cap.			Process Capability			Technological Capability		
	All	Local	Foreign	All	Local	Foreign	All	Local	Foreign	All	Local	Foreign
Constant	**0.1288**	0.0899	0.0483	**0.3703**	**0.5104**	0.1290	0.0263	**0.2179**	-0.3087	**0.1764**	**0.2728**	-0.0367
	(1.977)**	(1.038)	(0.388)	**(4.439)***	**(4.540)***	(0.8180	(0.264)	**(2.203)****	(-1.446)	**(2.936)***	**(4.187)***	(-0.296)
BI	0.0307	0.0132	0.0265	0.0942	-0.1021	**0.1994**	0.0458	-0.0317	0.0794	0.0578	-0.0402	0.1033
	(0.537)	(0.145)	(0.272)	(1.289)	(-0.870)	**(2.213)***	(0.525)	(-0.307)	(0.653)	(1.097)	(-0.592)	(1.448)
HTI	-0.1749	0.0035	**-0.3114**	-0.0231	-0.2427	0.2476	-0.2168	-0.2683	-0.0356	-0.1399	-0.1692	-0.0363
	(-1.724)	(0.026)	**(-1.962)****	(-0.178)	(-1.378)	(1.360)	(-1.401)	(-1.731)	(-0.145)	(-1.496)	(-1.658)	(-0.252)
NC	**0.3113**	**0.4011**	**0.2725**	**0.1862**	-0.0024	0.2190	**0.3711**	0.2585	**0.3476**	**0.2896**	0.2191	**0.2795**
	(3.605)*	**(2.481)****	**(2.661)***	**(1.987)****	(-0.011)	(1.692)	**(2.820)***	(1.401)	**(1.990)****	**(3.640)***	(1.803)	**(2.729)***
GN	**0.2556**	**0.3058**	**0.4058**	-0.0476	0.2356	-0.0049	**0.2935**	0.1005	**0.6126**	**0.1680**	**0.2139**	**0.3333**
	(2.975)*	**(2.335)****	**(2.834)***	(-0.433)	(1.387)	(-0.027)	**(2.235)****	(0.673)	**(2.489)***	**(2.121)****	**(2.175)****	**(2.327)****
XPerct	**0.3101**	0.0203	**0.4336**	**0.2442**	0.2690	0.1751	0.1488	**0.5338**	0.0432	**0.2330**	**0.2744**	**0.2155**
	(3.647)*	(0.122)	**(4.079)***	**(2.246)***	(1.249)	(1.304)	(1.147)	**(2.818)***	(0.238)	**(2.973)***	**(2.199)****	**(2.027)****
Size	**0.0487**	**0.0729**	0.0366	-0.0589	-0.0595	-0.0574	-0.0134	-0.0367	-0.0333	-0.0072	-0.0077	-0.0167
	(1.937)**	**(1.978)****	(0.866)	-1.548)	(-0.993)	(-1.076)	(-0.296)	(-0.697)	(-0.462)	(-0.261)	(-0.224)	(-0.397)
Age	7.90E-5	-0.0029	0.0028	-0.0022	-0.0011	-0.0034	**0.0037**	0.0023	0.0050	0.0005	-0.0006	0.0013
	(0.050)	(-1.290)	(1.334)	(-1.103)	(-0.359)	(-1.288)	**(1.923)****	(0.896)	(1.383)	(0.309)	(-0.325)	(0.621)
N	93	35	58	93	35	58	93	35	58	93	35	58

Note: figures in parentheses refer to "z" statistics; * and ** refer to statistical significance at 1 and 5% respectively. Source : Survey Indonesian Automotive firms 2006, computed by Eviews 5.0

CONCLUSION

The empirical results of the paper interestingly shows that the liberalization that took place after the fall of the Suharto's regime has had a positive impact on local firms there were no obvious statistical difference in research development and process technology capabilities them and foreign supplier firms in the automotive industry in Indonesia. Despite the excesses that took place during the period of localization policies since 1971, sufficient capabilities seem to have evolved to enable local firms to compete with foreign firms in a more even playing field following deregulation from the late 1990s.

The results also confirm that of export-orientation which is caused by liberalization of the sector has already improved the technological capability of the sector. It implies that export orientation has succeeded to impose the Indonesia automotive firm to improve their technological capability as involving in international market required advanced technological capability to maintain the competitiveness.

Local firms enjoyed a slightly higher RD mean than foreign firms but that seems to be because of higher investment in R&D by the former to offset the access the latter enjoys from abroad. Foreign firms enjoyed higher export intensities than local firms, which seems to be a consequence of regional production networks established by foreign multinational assemblers in Southeast Asia.

The presence of foreign firm, however has resulted stronger global networking has present significant influence on the improvement of Technological capabilities of the sector. On the contrary there is no influence of the global networking on the RD, which implies that local firms still have to rely heavily on their own R&D. The result implies that the presence of regional production network especially in ASEAN countries as an implication FTA has bear the influence of global networking on HR, PT and TC. From other perspective, even though the inter-linkage between the firms in ASEAN countries becoming stronger, R&D activities were still conducted in the parents countries.

The network cohesion has also presented significant impact on the HR, PT and TC. Different with the Global networking, network cohesion has provided slightly impact on RD Development. However, from network cohesion perspective, interaction between local firms and local firms, directly or indirectly has hold up the RD activities in the firms.

Because they are supplier firms, size did not seem to matter in RD and PT capabilities, while larger firms enjoyed higher RD capabilities than smaller firms. Firm which has longer experience in operating the facilities were considered enjoy longer experience and tacit knowledge hence the result showed the longer operating the firms the higher their PT.

Based on the above explanation, the presence of the foreign firms did not directly improve the technological capability of local firms. However, considering the Global Networking and Network Cohesion which resulted from interaction between foreign and local firms, which has also proven has significant influence on technological capability, we may conclude that the presence of foreign firms has improved the local firms capabilities.

However, various policies must be taken by Indonesian Government, especially for foreign firms, so they will be imposed to improve significantly their technological capabilities and also maintain favorable situation for technology spillover activities. This conditions not only benefiting the local firms but also to foreign firms as it can provide stronger regional production network..

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