ESTIMATING THE IMPACTS OF CHANGES IN R&D AND FDI ON THE CHANGES IN COMPARATIVE ADVANTAGE: THE CASE OF ASEAN-5 MANUFACTURING EXPORTS 1991–2013

Noor Aida Noh[1*]
Mukhriz Izraf Azman Aziz[1]
Lim Hock Eam[1]
[1]*School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, 06010 Sintok, Kedah Malaysia.*
**Corresponding author*

Abstract:\ There are extensive studies available identifying the determinants of comparative advantage including in the ASEAN-5 countries. However, knowing only the determinants of comparative advantage is not sufficient as the determinants of changes in comparative advantage also need to be identified. Different or similar drivers may be involved in the changes of comparative advantage. From the perspective of changes in comparative advantage, further insights can be obtained since it is largely ignored in the previous studies. This paper analyses the changes of comparative advantage on ASEAN-5 manufacturing exports over the period from 1991 to 2013 using Revealed Symmetric Comparative Advantage (RSCA) index for manufacturing export commodities at the three digit level of the Standard International Trade Classification (SITC). There are 215 commodities covering all the ASEAN-5' manufactured goods. Results revealed significant effects of changes R&D and FDI on the changes of comparative advantage in the ASEAN-5. It was shown that R&D and FDI are important in increasing the comparative advantage of manufacturing commodities. These findings incur important policy implications that include helping the identification of product specialisation for enhancing competitiveness and promoting economic growth.

Keywords: Revealed Symmetric Comparative Advantage (RSCA), research and development, Foreign Direct Investment, SITC, ASEAN-5.

INTRODUCTION

Asian economic performance has rapidly grown since the year 1960 especially among the East Asian countries such ASEAN-5. Each of the countries has its own way of managing the economy activity based on its specialisation. A country specialised in the production of certain goods or services is usually an export-oriented country.

The data in Figure 1 illustrates the export value according to technology classification (Lall, 2000). It was clearly observed that Malaysia is the second highest among all ASEAN-5 (after Singapore). Overall, the export of all technology levels has increased over the period of 2010 to 2013. The value of primary products (PP) of Indonesia has increased further compared to other countries. For the resource based manufactures (RB), Thailand showed the highest value compared to Malaysia and Indonesia. In terms of low technology manufactures (LT), Indonesia gained higher value compared to others. Furthermore, Singapore and Thailand demonstrated the highest value in medium technology manufactures (MT). Lastly, in high technology manufactures (HT), Singapore indicated the highest value comparatively to others.

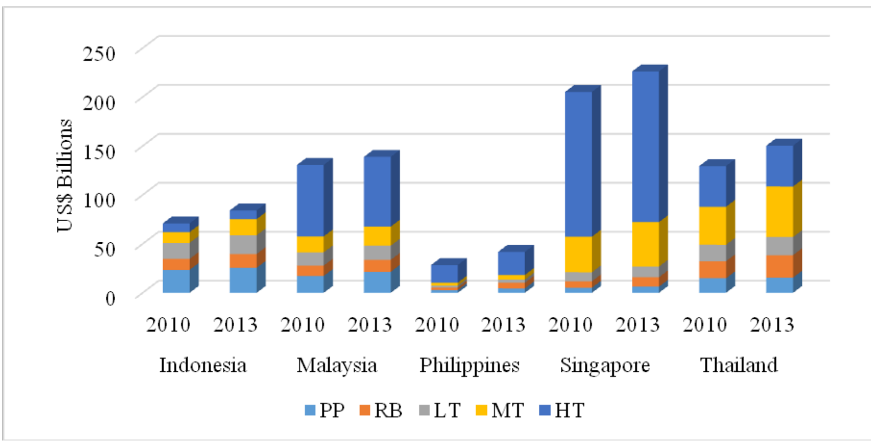

Figure 1 Export by level manufacturing commodities

Source: UN-Comtrade (2010 & 2013)
Note: PP = primary products, RB = resource based manufactures, LT = low technology manufactures, MT = medium technology manufactures, HT = high technology manufactures

ASEAN-5 has successfully increased its competitiveness and attracted various researchers to conduct their study in examining the determinants of this ASEAN-5 success. However, ASEAN-5' industrialisation revealed that comparative advantage (RCA) is an important element as this factor relates to its contribution to industrial development and international competitiveness. Thus, this study attempts to investigate the effects of R&D and FDI on comparative advantage of ASEAN-5. It is important to note that the R&D

and FDI have been accepted as the determinants of comparative advantage for all countries by previous studies. Figure 2 and 3 show the pattern of R&D and FDI for ASEAN-5 where Singapore showed the highest percentage for R&D expenditure and FDI compared to other countries.

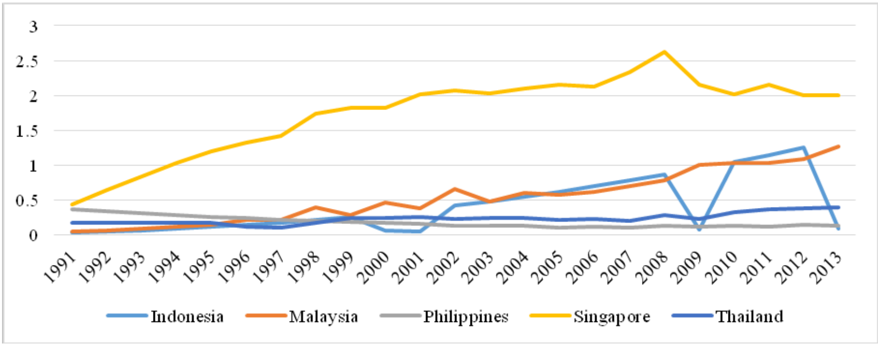

Figure 2 Research and development expenditure (per cent of GDP)
Source: World Development Indicator (various year)

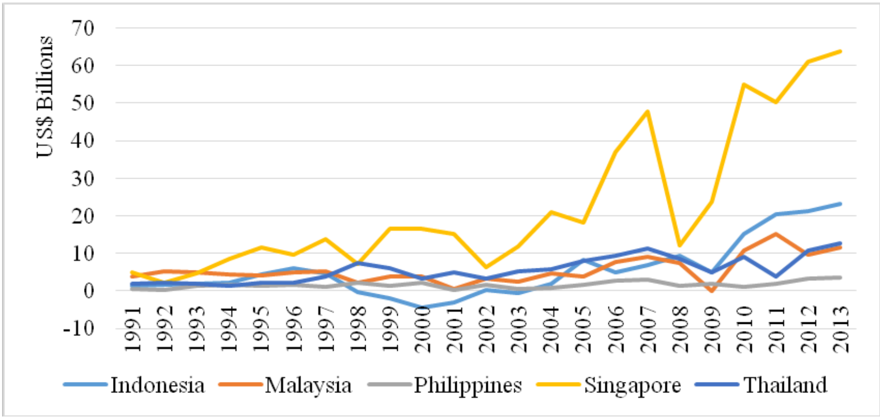

Figure 3 Foreign Direct Investment net inflows
Source: World Development Indicator (various year)

The analysis of the changes in R&D and FDI on the changes in RSCA was focused on the manufacturing sector of five ASEAN [1] countries namely Malaysia, Thailand, Singapore, Philippines and Indonesia commonly referred to as the ASEAN-5. This is due to the significant role of manufacturing sector in the economy of ASEAN-5. For example, the ASEAN-5's manufacturing contributes more than 30% of their GDP (Table 1). This highlights the importance of manufacturing to ASEAN-5 and hence, it is of interest to examine their competitiveness. The manufacturing sector is a major structural component of economic activities often regarded as the basic driving force of the economic activities among ASEAN countries. The economics of Malaysia, Thailand and Indonesia are mainly driven by manufacturing sector while Singapore and the Philippines economics come from the service sector (Table 1).

Table 1 ASEAN-5 economic structure

Agriculture Manufacturing Services	1992	1997	2002	2007	2013
Malaysia	15:41:4	11:45:44	9:45:46	10:45:45	9:40:51
Thailand	12:38:50	9:41:50	9:43:48	11:45:44	11:38:51
Singapore	1:33:66	00:33:67	00:32:68	00:29:71	00:25:75
Philippines	22:33:45	19:32:49	13:35:52	12:33:55	11:32:57
Indonesia	19:40:41	16:44:40	15:45:40	14:47:39	14:44:42

Note: The values show the percentage of GDP of agriculture, manufacturing and services in the ASEAN-5 economy.
Source: World Bank (various year).

Figure 4 below displays the mean of RSCA in ASEAN-5 by technology classification of export. Among the ASEAN-5 countries, Singapore has a comparative advantage in high technology manufactures compared to others while Indonesia has comparative advantage in primary products. Obviously, Thailand showed comparative advantage in the resource based manufactures and has comparative advantage in low and medium technology manufactures comparatively to other countries.

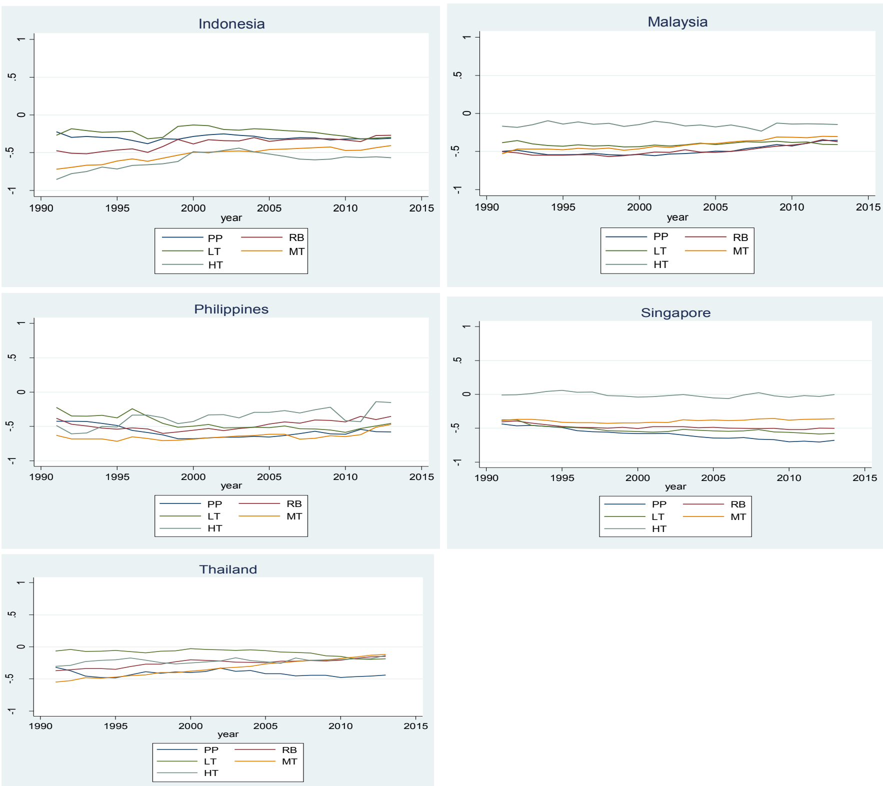

Figure 4 Mean of ASEAN-5 RSCA
Source: Un-Comtrade (various years)

The impact of changes in R&D and FDI on the RSCA is vital since the dynamic of comparative advantage provides a valuable input for the government's international trade policies. For instance, after a certain period (5 years) implementing policies to improve high technology sector's comparative advantage, the question that follows is: can we achieve this? This paper begins with a brief discussion on the comparative advantage and discusses the previous studies about the effects of the FDI and R&D. Data and methods are discussed in the next section. This is followed by the presentation of empirical results as well as the analysis of the findings. Finally, concluding remarks are given at the end of the paper.

LITERATURE REVIEW

Revealed Comparative Advantage (RCA)

Comparative advantage is the ability of a country to offer goods at a lower cost than that of other countries and thus should concentrate in making the goods which have a comparative advantage. In 1965, Bela Balassa has introduced the concept of RCA, which has been widely used by other researchers. According to Balassa, the RCA is a measurement of country's comparative advantage based on relative export ratio of a particular commodity of a particular country against that of the world. Furthermore, RCA index is used to compute the standard deviation to measure the degree of specialisation and export diversification gain by a country.

Recent study by Zam and Yakob (2017) analysed the changes of trade pattern for Malaysia's exports by calculating the RCA based on 144 manufactures' comparative advantages in the world from 2010 to 2015. They classified 144 different types of manufactures based on technology level with five general groups and nine small groups covering the majority of Malaysia's manufactured goods. Their results indicated that most of the products with comparative advantage in the world market are high technology products particularly E&E and process industries products. However, Malaysian manufactured products' competitiveness has shifted from low technology products to medium technology products.

Wei and Chunming (2012) used RCA to study the pattern of China's manufactured exports in the world and Vietnam market from 2002 to 2009 based on 144 kinds of manufactures categorised by technology level. They noted that most of the products with the comparative advantage are low technology products and the comparative advantage for China medium technology products has improved. Nevertheless, the comparative advantage index was low. Furthermore, it was also indicated that China manufactured exports are having high comparative advantage in the world market compared to those of the US market.

Another study by Vaidya, Bennett and Liu (2007) focused on China manufactured sector using 27 product groups. They used RCA to represent high, medium and low technology sectors to know which China's comparative advantage in manufacturing has shifted towards high technology sectors between 1987 and 2005. The study found that while China maintains its competitiveness in low technology labour intensive products, they gained comparative advantage in selected medium technology sectors as well as high technology telecommunications and automatic data processing equipment sectors.

Meanwhile, the study done by Aini, Roda, and Fauzi (2010) analysed Malaysia's comparative advantage of wood products in the European market and found that high comparative advantage products are the secondary processing and mechanised mass market products. The RCA is relying on the quantity traded where high quantity does not indicate high comparative advantage. According to the study, there are many factors influencing the comparative advantage such as abundant resources, communication and technology, production cost and demand pattern.

Muhammad and Yaacob (2008) studied the export competitiveness of Malaysian E&E products with the result from the RCA showing that Malaysia's E&E products highly perform only in the US market for almost all SITC. Meanwhile, Indonesia has monopolised the Singapore market while Hong Kong was dominated by China. Malaysia's E&E exports to the world generally have comparative advantage over other competitors namely Indonesia, Thailand and China. Yunus et al. (2010) analysed the shifting export specialisation to Singapore by estimating RCA indices over time. As a result, they discovered that Malaysia competitiveness has shifted from agro-based industry to semi-manufactured products especially iron, steel and zinc.

In order to measure international trade specialisation, the analysis of Balassa's RCA should be adjusted so that it becomes symmetric around its neutral value. The proposed adjusted index is called 'revealed symmetric comparative advantage' (RSCA). Laursen (2015) agreed that RSCA is the best index to measure comparative advantage.

Recent analysis done by Noh, Aziz & Eam (2018) reported that the changes of comparative advantage in Malaysia's manufacturing export over the period from 1990 to 2013 were identified using RSCA index. They found that there were minor changes in the patterns of comparative advantage in Malaysia. Relatively, there are more dynamic changes in low technology manufactures than the primary, resources based, medium technology and high technology manufactures. This suggests that Malaysia is more solid on low technology products. Another study by Widodo (2009) using RSCA indicated changes in the patterns of comparative advantage in the ASEAN+3 over the period from 1976 to 2005. The increase in overall comparative advantage is encouraged by further increase in comparative advantage of groups of products with no or lower comparative advantage in the past. The comparative advantage pattern of the ASEAN is becoming similar to Japan.

Research and Development (R&D)

Previous studies have emphasised the importance of R&D as the critical factor in sustaining high growth rate in the long run. Therefore, it follows that specialisation plays a vital role in the growth process of a country (Lucas, 1988). R&D is an important precondition for the economic growth and development as well as for the improvement of export performances and competitiveness of national economies. These factors become crucial when an economy decides to open to the international market to benefit from the gains of foreign trade where the scale and reallocation effects of the international integration can be better achieved and exploited when a country is specialised in increasing returns to scale sectors (Grossman & Helpman, 1991).

Many studies have investigated the empirical relationship between the R&D and export. For instance, Sandu and Ciocanel (2014) conducted a study examining the impact of R&D on high technology export. They noted that positive expenditure on R&D have a significant impact on increasing the export of medium and high technology products. However, the impact of R&D may be stronger or weaker depending on the country's specialisation in high technology sub sectors. In the US and Europe where Aerospatiale industry is developed, high technology exports are more related to investment in R&D, whereas in information technology products manufacturing dominated by

MNC, national RDI investments and activities are less relevant with regards to high technology exports. High levels of R&D expenditures are being correlated with high levels of exports in high technology products. Example, China as the world leader in high technology exports volume. High technology products mainly made of imported parts and components should be called 'Assembled High-tech'(Xing, 2012). Fu, Wu, and Tang (2011) mentioned that the success of Chinese high technology exports does not result from the heavy R&D expenditures and technological progress. The R&D expenditures and new product output as independent variables are weakly correlated to high technology exports dominated by multinationals.

There were various methods used to investigate the relationship between R&D and productivity. In Taiwan, R&D had a significant impact on firm productivity growth (Wang, 2003). Tsai and Wang (2004) estimated the impact of R&D on productivity within the private sector with further analysis of the different impacts of R&D within high technology and traditional manufacturing firms and examine the spillover effects from R&D investment in the high technology sector on productivity growth within the traditional industries using a sample of 136 large manufacturing firms during the period from 1994 to 2000. They discovered that Taiwan's R&D investment had a significant impact on firm productivity growth with output elasticity standing at 0.18.

According to Sterlacchini and Venturini (2014), R&D investment is a crucial condition for boosting manufacturing productivity in developed countries classified as technology followers. Verspagen (1995) examined that the impact of R&D on output was positive and significant only in high technology sectors, while there were no significant effects for medium and low technology sectors. Similar findings have emerged from more recent sectorial analyses including those performed by Ortega-Argilés et al. (2010). Additionally, the past study considered the role exerted by inter-industry R&D spillover, while the latter showed that the productivity growth of medium and low technology sectors was significantly affected by the investment in physical rather than R&D capital. This evidence confirmed that R&D expenditures are particularly concentrated in the industries that are more apt to translate their technological or knowledge investment into productivity gains due to higher technological opportunities.

Ismail (2013) studied the innovation and high technology in Asian countries using R&D as a proxy for innovation. The innovation in Asian countries dominantly brought by FDI through the process of learning by importing is getting stronger, while the import of high technology product decreases for importing countries. FDI and innovation in exporter's country is positive, thus implying the importance of FDI in Asian countries to boost innovation activities. It was confirmed the theory that innovation activities are the key drivers in the export of high technology products in Asian countries through the investment from multinational firms.

Khan (2015) demonstrated that the developing countries should concrete on R&D to achieve a sustainable economic growth. Chen et al. (2015) noted a positive relationship between R&D specialisation and productivity growth. The allocating R&D resources to specific niche industries can induce positive specialisation benefits (such as sufficient levels of scale and accumulation of experience) on productivity. The R&D specialisation in process innovation-oriented industries is associated with higher productivity growth.

Meanwhile, Vasić, Kecman, and Mladenović (2016) stated that R&D intensity has an impact on competitiveness and growth in Serbia. There was a positive correlation between the annual growth rate of R&D investments and annual GDP growth. Moreover, EU in 2002 has set the target level of R&D investment to 3% GDP, while in the EU28, the average level of investment of only 2% GDP was reached. However, EU countries have shown significant differences not only in the amount of national R&D investment level, but also in its structure.

Noland (1996) used panel data on Japan manufacturing to study the impact of R&D activities on trade. Japan was found to have a comparative advantage in goods intensive in total, privately funded, and applied R&D activities as well as a comparative disadvantage in publicly funded and basic R&D intensive goods. Balassa and Noland (1989) regressed measures of revealed comparative advantage against the R&D expenditures to sales and other factor intensity variables. They found that over the period 1967 to 1983, R&D intensity went from being negatively associated with Japanese revealing comparative advantage to positively associated with Japan's trade specialisation.

Overall, previous empirical studies demonstrated a relatively strong impact of R&D as shown by their empirical analysis on the development of an economy. For example, R&D have favourable impacts on export (Sandu & Ciocanel, 2014), productivity (Tsai & Wang, 2004) competitiveness (Vasić, Kecman & Mladenović, 2016) and specialisation (Chen et al., 2015). However, previous studies on R&D largely ignored the impacts of changes in R&D on the changes in comparative advantage.

Foreign Direct Investment (FDI)

An economist believes that FDI is an important element of economic development in all countries especially for the developing ones. FDI increases productivity, competiveness and causes the spillover of technology (Denisia, 2010).

A study by Waldkirch (2011) indicated a comparative advantage motive by FDI in Mexico. Comparative advantage in unskilled labour intensive industries is an important determinant of inward FDI. Skill endowment differences are positively correlated with FDI. However, when Mexico grows relatively more skilled labour (and capital), the FDI decreased. Nevertheless, the increase in market size and a decrease in dissimilarity to developed country markets would increase FDI where the net effect depends on the relative magnitude of changes.

Chandran and Krishnan (2008) noted that FDI plays an important role in stimulating the growth of manufacturing sector in Malaysia. In the long run, increase in FDI contributes to increase manufacturing value added output in Malaysia. Moreover, labour and technology progress positively contributed to the growth.

Meanwhile, the study by Aziz and Dahalan (2015) on ASEAN-5 countries noted that FDI was positively significant in most of commodities grouping low, medium and high technology. Driffield and Munday (2000) stated that sectors with a higher level of foreign involvement including the E&E industry tend to have higher productivity. However, industry comparative advantage together with a series of industry specific characteristics are the important determinants of new foreign manufacturing investment, providing evidence for the dynamic benefits of foreign direct investment in the UK economy. In China, Zhang (2014) conducted a study indicating that FDI has large positive effects on industrial performance; such effects are much greater on low technology manufactures than medium and high technology industries with enhanced contribution by FDI's interaction with local human capital. The role of FDI increases with FDI inflows over the period, whereas changes in FDI affect the changes in industrial performance.

Castejón and Woerz (2006) as well as Nezakati, Fakhreddin and Vaighan (2011) concluded that FDI generates positive impact on the manufacturing sector growth. In addition, Nezakati, Fakhreddin and Vaighan noted that the domestic and FDI are in a positive relationship generating positive impact towards Malaysia economy and productions in the long run. Castejón and Woerz (2006) found that the impact of FDI on the development of an economy is different depending on the stage of development of the country. Their study indicated that the role for FDI has given a significant positive impact that is much stronger in developing countries compared to that of undeveloped countries.

However, study by Liu and Daly (2011) presented the existence of negative relationship between FDI and growth in the manufacturing sector. They proved that when the manufacturing sectors are expanding, skilled labour are much preferable, hence increasing the cost of labour. However, high labour cost indicates high production cost, which may draw the FDI away from the countries. One of the reasons that FDI might positively impact the manufacturing sector in Malaysia can be explained by the fact that it has transitioned into a high technology, high efficiency sector focusing on the production of exported goods. FDI is an effective channel by which technology is transferred to the receiving country, and this benefit is taken advantage of most by developing countries (Fakhreddin, Nezakati & Vaighan, 2011).

Masron et al. (2012) examined the effects of FDI in one sector to the output of other sectors within manufacturing sector. They noted that Malaysia is among the major receipts of world FDI. While the benefits of FDI have been documented, the actual technology related effect is still ambiguous.

This is particularly important to countries like Malaysia as the volume of FDI inflows keep on decreasing over the time recently. It raises a lot of questions regarding the real benefits that Malaysia is able to reap from their presence. If FDI previously came in merely targeted cheap labour supply and abundant natural resources, Malaysia can expect to lose FDI gradually and at the same time cannot anticipate huge return. Utilising several manufacturing sub-sectors in Malaysia, this study attempts to investigate the spillover effect of FDI on Malaysian economy focusing on manufacturing sector. It was found that positive spillover effect has occurred as well as the FDI that inflows in certain sector is likely to exert a negative consequence on its own sector as well as to other sectors.

Girma, Görg and Pisu (2008) investigated whether or not there exist productivity spillover from FDI using a panel data set of UK companies from 1992 to 1999. Their findings pointed to the general conclusion that the export orientation of domestic and foreign multinationals alike is relevant to productivity spillover. Keller and Yeaple (2009) estimated international technology spillover to the US manufacturing firms via imports and FDI between 1987 and 1996 and found that FDI is accounted for between 8% and 19% productivity growth of the US domestic firms. Similarly, studies in search of spillover from FDI largely found that sectors with a higher level of foreign involvement tend to have higher productivity and higher productivity growth (Blomström, 1986; Blomström & Persson, 1983; Caves, 1974; Globerman, 1979; Görg & Strobl, 2003).

The conclusion they drew was relatively strong as their empirical analysis showed that the impact of FDI on the development of an economy is different depending on the stage of development of the country. Their study indicated that the role for FDI in giving significant positive impact is much stronger in developing countries compared to that of undeveloped countries. There are extension studies available on the effects of R&D and FDI on a country's RCA; however, the effects of R&D and FDI are yet to be explored from the perspectives of changes.

In summary, it was found that previous studies have ignored the perspective of changes in comparative advantage. Consequently, this ignorance has hindered this present study from obtaining further insights on the comparative advantage among the ASEAN-5 countries. Moreover, according to Gujarati (2009), a variable could be viewed not only at its level, but also from the perspective of changes, which is at the first difference of variable. In this context, to have a complete picture of an economic phenomena, instead of studying the relationships between variables in the form of level, one should examine their relationship in the form of changes. Surprisingly, it was discovered that the perspective of change is lacking in the literature of comparative advantage among ASEAN-5. This is the gap that the present study aims to address with. In terms of theoretical framework, this study is an empirical study and the theoretical framework is not presented. In general, there are three related theories that can be used to construct the theoretical framework; putty-putty model (Pindyck and Rotemberg, 1983), neoclassic model of unemployment (Hamilton, 1988) and sectorial shifts and cyclical unemployment (Lilien, 1982). These theories have been employed by Mukhriz Izraf and Jauhari (2015) to construct the theoretical framework.

DATA AND EMPIRICAL METHOD

Data

Data for 215 manufacturing export commodities were obtained from the United Nation Comtrade, which is based on Revision 3 of the Standard International Trade Classification (SITC Rev. 3) at the three-digit level. RSCA was calculated for the 215 manufacturing export commodities and aggregated into five main groups and 10 specific groups. These include primary product (PP), resources based manufactures (RB1 and RB2), low technology manufactures (LT1 and LT2), medium technology manufactures (MT1, MT2 and MT3) and high technology manufactures (HT1 and HT2). For econometric estimation, this study utilised variables suggested in traditional trade theory and augmented by recent literature for determinants of comparative advantage. The variables are defined as follow;

RSCA by Dalum, Laursen and Villumsen (1998) was chosen to measure comparative advantage. The RSCA index is a simple decreasing monotonic transformation of RCA or Balassa index (Balassa, 1965) formulated as follows:

$$RCA_{ij} = (X_{ij}/X_{in})/(X_{rj}/X_{rn}) \quad (1)$$

where RCA_{ij} represents revealed comparative advantage of country *i* for group of products (SITC) *j*; and X_{ij} denotes total exports of country *i* in group of products (SITC) *j*. Subscript *r* refers to all countries without country *i*, and subscript *n* refers to all groups of products (SITC) except group of product *j*. The values of the index vary from 0 to ∞. RCA_{ij} greater than one means that country *i* has comparative advantage in group of products *j*. In contrast, RCA_{ij} less than one implies that country *i* has comparative disadvantage in group of products *j*. Since RCA_{ij} turns out to produce values that cannot be compared on both sides of one, Dalum et al. (1998) proposed RSCA index, which is formulated as follows:

$$RSCA_{ij} = (RCA_{ij}-1)/(RCA_{ij}+1) \quad (2)$$

The values of $RSCA_{ij}$ index can vary from minus one to one (–1 $RSCA_{ij}$ 1). $RSCA_{ij}$ >0 implies that country *i* has comparative advantage in group of products *j*. In contrast, $RSCA_{ij}$ <0 implies that country *i* has comparative disadvantage in group of products *j*.

Real FDI is the investment of foreign assets into domestic structures, equipment and organisations. It does not include foreign investment into stock markets. FDI is an important determinant of a country's comparative advantage as shown by Dunning (1993) and Driffield & Munday (2000). The series were obtained from World Development Indicators. Research and development (R&D) is the percent of GDP government spent on research and development. These variables were taken from World Development Indicators.

Econometric Estimation

The number of equations to estimate in each group differs according to the number of commodities listed in each technological content classification. There were 46 commodities in PP, 29 commodities in RB1, 25 commodities in RB2, 19 commodities in LT1, 24 commodities in LT2, 5 commodities in MT1, 20 commodities in MT2, 29 commodities in MT3, 11 commodities in HT1, and 7 commodities in HT2. Using these groupings, the probit regressions looked at the changes in R&D and FDI on changes in RSCA from 1991 to 2013, using the following equation:

$$ChangeRSCA_{jit} = \beta_0 + \beta 1 changelogFDI_{jit} + \beta_2 changelogR\&D_{jit} + \delta' Z + \varepsilon_{jit} \quad (3)$$

Where,

Changes in RSCA=1, if changes RSCA more 0, and
Changes in RSCA=0, if changes RSCA less than 0.
j = the equation number (11= primary product PP, 12= resource based RB1&RB2,
13 = low technology LT1 & LT2, 14 = medium technology MT1, MT2 & MT3, 15= high technology HT1 & HT2).
Z= the matrix and other control variables (Real oil price domestic, Real Gross Domestic Product, Openness, Manufacturing Value Added, Capital, Labour, Oil Demand)

Since the change in RSCA is in binary category, a Probit model was employed in the estimation.

RESULT AND ANALYSIS

Table 2 presents the impacts of changes in R&D on the changes in RSCA by technological classification of exports based on Lall (2000). In PP, changes in R&D have positive effect on changes in RSCA in 2010. This implies that changes in R&D have brought positive effect on changes in RSCA in PP 2010. The changes in R&D have significant and positive effect on changes in RSCA 1995 and 2010 in RB commodities. This suggests that changes in R&D will increase the changes in RSCA on RB commodities. In the LT, changes in R&D have significant and positive effect on changes RSCA (1995, 2010 and 2013) and negative effect on changes in RSCA (2000 and 2005). The changes in R&D have increased changes in RSCA 1995 in MT commodities. In the HT, changes in R&D have positive effect on changes in RSCA. This indicates that the increase in R&D 1995 will increase changes in RSCA.

Table 2 Changes in R&D on changes in RSCA

R&D	PP	RB	LT	MT	HT
(1995-1991)	0.582	0.034**	0.034**	0.014**	0.033**
	(0.129)	(0.437)	(0.437)	(0.519)	(0.799)
(2000-1996)	0.130	0.996	0.025**	0.567	0.992
	(-0.244)	(-0.001)	(-0.381)	(-0.075)	(0.002)
(2005-2001)	0.630	0.176	0.090*	0.367	0.807
	(0.113)	(0.283)	(-0.390)	(-0.197)	(-0.087)
(2010-2006)	0.005***	0.006***	0.008***	0.134	0.328
	3.430	(3.127)	(3.195)	(1.714)	(1.843)
(2013-2011)	0.141	0.720	0.050*	0.274	0.938
	(0.516)	(-0.117)	(0.701)	(0.359)	(0.043)

Note:
1. *** = p<0.01, ** = p<0.05, * = p<0.1
2. The values in parentheses represent coefficient and the values not in parentheses represent the p-value.
3. Changes are referred to 5-year period. For example, changes in 2010 were referred to the year 2010 compared to the year 2006 (2010–2006).

Table 3 shows the impacts of changes in FDI on changes on RSCA by technological classification of exports based on Lall (2000). In PP commodities, the changes in FDI have negative effect on changes in RSCA (2006 and 2005). It shows that the increase in FDI will decrease the RSCA. The changes in FDI have significant and positive effect on changes in RSCA 1995 as well as negative and significant effect on changes in RSCA 2010 in RB commodities. In low technology manufactured, changes in FDI have negative effect on changes in RSCA (2000, 2010 and 2013) and positive effect on changes in RSCA (1995). The changes in FDI have increased changes in RSCA (1995). Nevertheless, in 2010, increase in FDI led to a decrease of RSCA in MT commodities. Changes in FDI have negative effect on changes in RSCA 2010 and positive effect on changes in RSCA (2013).

Table 3 Changes in FDI on changes in RSCA

Year	PP	RB	LT	MT	HT
(1995-1991)	0.185	0.034**	0.034**	0.000***	0.423
	(0.336)	(0.476)	(0.477)	(0.786)	(-.0.333)
(2000-1996)	0.844	0.905	0.014**	0.322	0.153
	(-0.054)	(-0.028)	(-0.684)	(-0.227)	(0.565)
(2005-2001)	0.009***	0.710	0.938	0.124	0.895
	(-0.500)	(0.063)	(-0.014)	(-0.274)	(-0.039)
(2010-2006)	0.018**	0.021**	0.000***	0.013**	0.057*
	(-1.803)	(-1.637)	(-2.718)	(-1.777)	(-2.263)
(2013-2011)	0.892	0.477	0.093*	0.304	0.004***
	(-0.029)	(0.143)	(-0.372)	(0.207)	(-1.063)

Note:
1. *** = p<0.01, ** = p<0.05, * = p<0.1
2. The values in parentheses represent coefficient and the values not in parentheses represent the p-value.
3. Changes are referred to 5-year period. For example, changes in 2010 were referred to the year 2010 compared to the year 2006 (2010–2006).

CONCLUSION

In ASEAN-5, the changes on R&D and FDI have been found to have significant effects on the changes in RSCA across various levels of technological classification of export. During the 1990's, the changes in R&D have significant impacts on the ASEAN-5's comparative advantage in resource based, low technology, medium technology and high technology manufactures. However, after 23 years, the impacts of R&D remained only in low technology manufactures. This implies that the effectiveness of the R&D expenditure is diminishing in terms of comparative advantage of other sectors except low technology. The R&D of ASEAN-5 appeared not supporting the improvement of high technology comparative advantage. This finding suggests that ASEAN-5 is losing the comparative advantage in high technology manufactures. ASEAN-5 needs an investment on R&D in all technology classification effectively to ensure that it can increase the comparative advantage of all sectors. This R&D investment is especially important for high technology manufactures to achieve or maintain the status of developed country.

For the changes in FDI, its impacts on ASEAN-5's comparative advantage have been found to be significant and positive in the resource based, low technology and medium technology manufactures in the early time, 1990's. However, these positive and significant impacts on the comparative advantage disappeared after 23 years; even worst, for the low and high technology manufactures, the impacts became negatively significant. This implies that the amount of FDI that ASEAN-5 obtained is not useful in terms comparative advantage. Thus, the ASEAN-5 needs to focus on the quality of FDI instead of quantity. It needs to attract on FDI especially on high technology manufactures and for the others.

It is important to note that R&D and FDI are the engine of innovation and technological progress of a country. However, if the R&D and FDI are focusing on imitation without innovation, it has limited effectiveness to improve comparative advantage. The major policy implications that could be derived from this study are: ASEAN-5 governments may at first adopt policies encouraging foreign direct investment to foster technology transfer and industry-wide knowledge spillover. However, once the country's technological capability has progressed to a certain degree and ready to be innovators, the policies need to encourage R&D and FDI that are able to provide conducive environment to innovations, which leads to comparative advantages in the international trade.

Note

[1] ASEAN was established in 1967 to accelerate economic growth, promote regional peace and stability and enhance cooperation on economic, social, cultural, technical and educational matters. The five founding countries- Indonesia, Malaysia, the Philippines, Singapore and Thailand were later joined by Brunei Darussalam (Brunei) in 1984, Vietnam (1995), Burma (1997), Laos (1997), and Cambodia (1999).

References

Balassa, B. (1965). Trade liberalization and revealed comparative advantage. *The Manchester School of Economics and Social Studies*, *33* (2), 99–123.

Balassa, B. & M. Noland. (1989). The changing comparative advantage of Japan and the United States. *Journal of the Japanese and International Economies,* 3(2), 174–188.

Aini, Z. N., J.M, R., & Fauzi, P. A. (2010). Comparative advantage of Malaysian wood products in the European market. *National Postgraduate Seminar (NAPAS 2010)*.

Aziz, M. I. A., & Dahalan, J. (2015). The impacts of oil price fluctuations on revealed comparative advantage of manufacturing commodities for ASEAN-5 economies. *International Journal of Energy Economics and Policy*, *5* (4), 1098–1108.

Blomström, M. (1986). Foreign Investment and Productive Efficiency: The Case of Mexico. *The Journal of Industrial Economics*, *35* (1), 97–110.

Blomström, M., & Persson, H. (1983). Foreign investment and spillover efficiency in an underdeveloped economy: Evidence from the Mexican manufacturing industry. *World Development*, *11* (6), 493–501. https://doi.org/10.1016/0305-750X(83)90016-5

Castejón, C. F., & Woerz, J. (2006). Good or bad ? - The influence of FDI on productivity growth. *Tinbergen Institute, Erasmus University Rotterdam*, (10214), 1–31.

Caves, R. E. (1974). Multinational firms, competition, and productivity in host-country markets. *Economica*, *41* (162), 176–193. https://doi.org/10.2307/2553765

Chandran, V. G. R., & Krishnan, G. (2008). Foreign direct investment and manufacturing growth: The Malaysian experience. *International Business Research*, *1* (3), 83–90.

Chen, J. R., Chu, Y. P., Ou, Y. P., & Yang, C. H. (2015). R&D specialization and manufacturing productivity growth: A cross-country study. *Japan and the World Economy*, *34–35*, 33–43. https://doi.org/10.1016/j.japwor.2015.03.002

Dalum, B., Laursen, K., & Villumsen, G. (1998). Structural change in OECD export specialisation patterns; de-specialisation and stickiness. *International Review of Apllied Economics*, *12* (3), 423–443.

Denisia, V. (2010). Foreign Direct Investment theories: An overview of the main FDI theories. *Academy of Economic Studies*, *2* (2), 104–110. https://doi.org/10.1016/0306-9192(77)90003-3

Driffield, N., & Munday, Ma. (2000). Industrial and foreign performance, agglomeration, manufacturing investment in the UK. *Journal of International Business Studies*, *31* (1), 21–37.

Fu, D., Wu, Y., & Tang, Y. (2011). Does innovation matter for Chinese high-tech exports? A firm-level analysis. *Discussion Paper 11.21*.

Girma, S., Görg, H., & Pisu, M. (2008). Exporting, linkages and productivity spillovers from foreign direct investment. *The Canadian Journal of Economics*, *41*(1), 320–340.

Globerman, S. (1979). Foreign direct investment and spillover efficiency benefits in Canadian manufacturing industries. *Canadian Journal of Economics*, *12* (1), 42–56. https://doi.org/10.2307/134570

Görg, H., & Strobl, E. (2003). Multinational companies, technology spillovers and plants survival. *The Sacndinavian Journal of Economics*, *105* (4), 581–595.

Grossman, G. M., & Helpman, E. (1991). Trade, knowledge spillovers and growth. *European Economic Review*, *35* (2–3), 517–526. https://doi.org/10.1016/0014-2921(91)90153-A.

Gujarati, D. N. (2009). *Basic econometrics*. McGraw-Hill.

Hamilton, J. D. (1988). A Neoclassical Model of unemployment and the business cycle. *The Journal of Political Economy*, *38*, 593–617.

Ismail, N. wana. (2013). Innovation and high-tech trade in Asian countries. In. *International Conference on Recent Developments in Asian Trade Policy and Integration* (pp. 1–19). Retrieved from https://www.nottingham.ac.uk/gep/documents/conferences/2013/malaysia-conference/normaz-wana-ismail.pdf

Keller, W., & Yeaple, S. R. (2009). Multinational enterprises, international trade and productivity growth: Firm level evidence from the United States. *The Review of Economics and Statistics*, *91* (4), 821–831.

Khan, J. (2015). The role of research and development in economic growth: A review. *Munich Personal RePEc Archive*, (67303).

Lall, S. (2000). Working Paper Number 44 The Technological Structure and Performance of Developing Country Manufactured Exports, 1985–1998. *Working Paper*, (44), 1985–1998.

Laursen, K. (2015). Revealed comparative advantage and the alternatives as measures of international specialization. *Eurasian Business Review*, *5*, 99–115. https://doi.org/10.1007/s40821-015-0017-1

Lilien, D. M. (1982). Sectoral Shifts and cyclical unemployment. *Journal of Political Economy*, *90* (4), 777–793. Retrieved from http://www.jstor.org/stable/1831352?seq=1#page_scan_tab_contents

Liu, K., & Daly, K. (2011). Foreign Direct Investment in China manufacturing industry –Transformation from a low tech to high tech manufacturing. *International Journal of Business and Management*, *6* (7), 15–27. https://doi.org/10.5539/ijbm.v6n7p15

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7.

Masron, T. A., Zulkafli, A. H., & Ibrahim, H. (2012). Spillover effects of FDI within manufacturing sector in Malaysia. *Procedia - Social and Behavioral Sciences*, *58*, 1204–1211. https://doi.org/10.1016/j.sbspro.2012.09.1102.

Muhammad, N. M. N., & Yaacob, H. C. (2008). Export competitiveness of Malaysian Electrical and Electronic (E & E) Product: Comparative study of China, Indonesia and Thailand. *Intenational Journal of Business and Management*, *3*(7), 65–75.

Nezakati, H., Fakhreddin, F., & Vaighan, B. M. (2011). Do local banks credits to private sector and domestic direct investments affect FDI Inflow? (Malaysia evidence). *World Applied Sciences Journal*, *15* (11), 1576–1583.

Noh, N. A., Aziz, M. I. A., & Eam, L. H. (2018). An empirical analysis of changes in comparative advantage: The case of malaysia manufacturing exports 1990–2013. *International Journal of Social Science and Humanities Research*, *6* (1), 217–223.

Noland, M. (1996). Research and development activities and trade specialization in Japan. *Journal of the Japanese and International Economies*, *10* (8), 150–168. https://doi.org/10.1006/jjie.1996.0008

Ortega-Argilés, R., Piva, M., Potters, L., & Vivarelli, M. (2010). Is corporate R&D investment in high-tech sectors more effective? *Contemporary Economic Policy*, *28* (3), 353–365. https://doi.org/10.1111/j.1465-7287.2009.00186.x.

Pindyck, R. S., & Rotemberg, J. J. (1983). Dynamic factor demands and the effects of energy price shocks dynamic factor demands and the effects of energy price shocks. *The American Economic Review*, *73* (5), 1066–1079.

Sandu, S., & Ciocanel, B. (2014). Impact of R&D and innovation on high-tech export. *Procedia Economics and Finance*, *15* (14), 80–90. https://doi.org/10.1016/S2212-5671(14)00450-X

Sterlacchini, A., & Venturini, F. (2014). R&D and productivity in high-tech manufacturing: A comparison between Italy and Spain. *Industry and Innovation*, *21*(5), 359–379. https://doi.org/10.1080/13662716.2014.959315

Tsai, K.-H., & Wang, J.-C. (2004). R&D productivity and the spillover effects of high-tech industry on the traditional manufacturing sector: The case of Taiwan. *The World Economy*, *27*(10), 1555–1570. https://doi.org/10.1111/j.1467-9701.2004.00666.x

Vaidya, K., Bennett, D., & Liu, X. (2007). Is China's manufacturing sector becoming more high-tech? *Journal of Manufacturing Technology Management*, *18* (8), 1000–1021. https://doi.org/http://dx.doi.org/10.1108/VINE-10-2013-0063

Vasić, J., Kecman, N., & Mladenović, I. (2016). Research and development investment as determinant of international competitiveness and economic growth in Eu28 and Serbia. *Economic Themes*, *54* (2), 195–216.

Verspagen, B. (1995). R & D and productivity: A broad cross-section. *The Journal of Productivity Analysis*, *6*, 117–135.

Waldkirch, A. (2011). Comparative advantage FDI? A host country perspective. *Review of World Economics*, *147*(3), 485–505. https://doi.org/10.1007/s10290-011-0096-8

Wang, J. (2003). *Productivity growth and R&D expenditure in Taiwan's manufacturing firms*.

Wei, H., & Chunming, Z. (2012). The comparative advantage of Chinese manufactured exports. *Journal of Chinese Economic and Foreign Trade Studies*, *5* (2), 107–126. https://doi.org/10.1108/17544401211233507

Widodo, T. (2009). Dynamic comparative advantages in the ASEAN + 3. *Journal of Economic Integration*, *24* (1), 505–529.

Xing, Y. (2012). The People's Republic of China's high-tech exports-myth and reality. *ADBI Working Paper Series*, *357*.

Yunus, M. M., Mohamed, Z., Mahyideen, J. M., & Saidon, R. (2010). Reveled comparative advantage of Malaysian manufacturing: Malaysia and Singapore. *Prosiding Perkem V*, *1*, 278–288.

Zam, N., & Yakob, N. A. (2017). The comparative advantage of Malaysia manufactured exports. *Saudi Journal of Business and Management Studies*, *2* (5B), 521–531. https://doi.org/10.21276/sjbms

Zhang, K. H. (2014). How does foreign direct investment affect industrial competitiveness? Evidence from China. *China Economic Review*, *30*, 530–539. https://doi.org/10.1016/j.chieco.2013.08.003