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ICT Dynamics and Regional Trade Bias in Asia: Theory and Empirical Aspects

Beitrag zum EIIW-Projekt ***EU-Strukturwandel, Leitmärkte und Techno-Globalisierung***
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Zusammenfassung

IKT-Märkte in Asien sind durch eine starke Rolle der sektoralen ausländischen Direktinvestitionen gekennzeichnet, auf der einen Seite von den USA und auf der anderen Seite von der EU. Die Handelsströme, gesehen als Prozentsatz der gesamten Warenexporte, unterscheiden sich in den Regionen: Südostasien, Ostasien, Südafrika, EU 27 und Nordamerika; z.B. Südostasien verzeichnet einen relativ starken Anstieg des Intraregionalen Handels (relativ zu dem gesamten Warenhandel). Auch die Handelsströme der asiatischen Länder sind von den Regionen voreingenommen; der interregionale Handel Asiens mit der EU und Nordamerika hat sich mit der Zeit erhöht. In einigen Regionen Asiens ist der Handel mit Zwischenprodukten mit der Zeit gesunken. Bayerns regionale IKT Netzwerke sind dabei interessant zu betrachten. Die Panel Daten präsentieren neue Ergebnisse über den Nutzen von regionalen F&E Ausgaben.

Summary

ICT Markets in Asia are characterized by the strong role of sectoral foreign direct investment (FDI) inflows, namely from the US on the one hand, and from the EU on the other. Trade flows (determined here by examining trade flows as a percentage of total merchandise exports) differ in terms of regions: Southeast Asia, East Asia, Southern Africa, EU27 and North America; e.g., Southeast Asia recorded a fairly strong rise in intra-regional trade (relative to total merchandise trade). Also, the trade flows of Asian countries are biased with regard to the regions; the share of interregional trade of Asia's regions with the EU and North America have increased over time. In some Asian regions, trade in intermediate goods has decreased over time. Bavaria's regional ICT networks are interesting to consider in light of this finding. The panel data presented sheds new light on the benefits of regional R&D spending.

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1. Introduction

Information and communication technology (ICT) is the most dynamic sector in many OECD and Asian countries. As regards ICT production, there are short innovation cycles – and this in a high-technology sector. It is obvious that based on imported intermediate products and services, advanced ICT production can take place in North America, Europe and Asia. US as well as EU, Japanese, Korean and Chinese companies play a leading role in ICT production. Given the rapid regional growth and ongoing international technological catching-up in Asia it is particularly interesting to focus on Asian countries as a location of ICT production.

From a theoretical perspective, one may argue US ICT companies producing in Asia will produce rather advanced ICT products since from Asian locations one could export to both many Asian and indeed most OECD countries - where the latter clearly stand for users that require advanced products and technology, respectively; or the emphasis is more on standardized ICT products whose markets are strongly shaped by falling prices. As regards EU imports from leading exporters, empirical analysis has shown that mainly high technology products are exported from Japan and the US to the EU countries, however, exports from China were much more modest in terms of technology (Vandenbusche, 2014); moreover, it was also found that China's imports of intermediate products had reduced after 2012 (Galar, 2015) which indicates that China's domestic suppliers have increasingly started to replace foreign suppliers of intermediate products. The broader globalization dynamics also indicate that trade in intermediate products is increasingly important, however, in a regional and sectoral perspective it not clear from the outset whether or not regional trade of final products is also coinciding with regional trade in intermediate products and which interregional links in the world economy are the most crucial.

Interregional trade links could be shaped by specific geographical and political elements plus the impact from foreign direct investment in the respective regions. As regards the US and Asia, the Trans-Pacific Partnership project (TPP: signed in late 2015) of the Obama Administration is a potential driver for growing trade links between the US and Asia – and in some sectors a changing interregional trade equation will, of course, affect foreign direct investment dynamics. Moreover, Asian regional trade liberalization, e.g., in the form of the ASEAN single market starting in 2015, also stimulates changes in the international division of labor/knowledge as well as enhanced regional knowledge diffusion through more trade in intermediate products and more regional foreign direct investment. Additionally, there are bilateral trade liberalization initiatives from China (e.g., a trade pact with Australia in 2015).

Recent analysis by the Asian Development Bank has shown the importance of Asian regional integration (ADB, 2015) where growing intra-Asian trade and a particular role of special economic zones for economic development have been emphasized. Moreover, there is a growing role of global production sharing as emphasized by Helpman (2011) and Athukorala (2013). The latter has emphasized that the role of advances in production technology has allowed industry to slice up the traditional value chain into finer "portable" elements. With a more modular production technology, certain fragments of the production

process in some sectors have become "standard fragments" that can be used in a large number of products and ICT progress has facilitated the coordination of the production of components. ICT and the production sharing (fragmentation-based specialization) within global industries have a twin effect: Production sharing contributes to reducing costs of production and facilitates quick market penetration and innovation cycle trade; at the same time, scale economies linked to market expansion in turn will encourage higher R&D expenditures which enable producers to engage in the further fragmentation of production processes; and international liberalization of trade and foreign direct investment in the period 1985-2015 have facilitated such interdependent production dynamics. Moreover, Athukorala (2013) has highlighted major trends in trade occurring through global production networks whose role in East Asia – with a considerable role of China - has enormously increased from the early 1990s to the end of the first decade of the 21st century. By contrast, Sen (2014) shows that in South Asia such trade is rather small and with respect to India there are particular weaknesses so that South Asia lags behind East Asia. This is the broader picture for Asia.

Subsequently, there is a special focus on ICT and the key supply dynamics considered then for Asia are US foreign investors producing in that region and trade links of Asian sub-regions with the US and the EU are also taken into consideration. The fact that technology-intensive ICT production – often with short product cycles – has been playing an increasing role in Asia over time might reflect both high regional growth dynamics on the demand side as well as prospects to combine advanced OECD technologies with valuable complementary regional/local R&D resources so that techno-globalization is part of the Asian ICT dynamics.

The definition of techno-globalization is broad and depends on its context. In order to understand the meaning and the scope of techno-globalization, one may consider a taxonomy of techno-globalization which is developed by Archibugi and Michie (1995). In their taxonomy, the scope of techno-globalization can be grouped into three distinct groupings. The first grouping is the global exploitation of technology which covers firms' activities in exploiting their technology in the foreign market through international trade and the transfer of license activities. The second grouping is global technological collaborations which involve agents from more than one country. The collaborations may involve government research agencies, private research centers, and academic institutions. The last grouping of techno-globalization is the global generation of technology. This type of techno-globalization exists due to MNCs research activities. In a common practice, MNCs have a strong incentive to develop a global research network between the mother company and their affiliates in the host countries. Based on the taxonomy of techno-globalization which is developed by Archibugi and Michie (1995), one may focus on the trade channel and MNEs research activities to analyze the pattern of techno-globalization.

As regards the trade channel, Archibugi and Michie (1995) argue that techno-globalization is a consequence of the increase in international trade. This argument is later supported by Aggarwal (1999) who argues that an increase in international trade is expected to raise the diffusion of new technology into foreign markets. Techno-globalization is also strongly related to the ICT sector. Chopra (2006) emphasizes the role of telecoms and the IT sector in narrowing the gap between developed and developing countries. Techno-globalization is one of the four aspects of the process of globalization (Chopra, 2002). The other three

aspects are political globalization, economic globalization, and cultural globalization. Again, the role of MNEs in shaping economic globalization is also mentioned in the paper.

At the bottom line, this study analyzes techno-globalization in Asia by focusing on the trade channel (read trade in final products vs. intermediate products) and multinational companies' R&D activities in Asia. It is well known that in the 1980s Asian NICs had already attracted mainly US foreign direct investent inflows in computer technology and with rather liberal access to US markets there was indeed a double prospect for exports from US subsidiaries in Asia; ICT foreign direct investment (FDI) dynamics in the 1990s and the first decade of the 21st century might have followed a similar logic of FDI, innovation dynamics and trade. As regards the trade channel, one may consider both total trade flows and trade in intermediate products among regions. As regards the level of trade integration in the ICT sector – and its sub-sectors – between Asian sub-regions (East Asia, South East Asia and South Asia) and one can calculate trade bias indicators that identify the relative role of regional and inter-regional trade dynamics. As regards linkages among ICT sectors in the selected Asian countries, input-output analysis is considered a natural analytical starting point that allows to understand the regional ICT production and intermediate product trade dynamics. A particular challenge is to analyze the R&D activities of US subsidiaries in Asian ICT production – which are the main drivers of such R&D activities and from which policy conclusions can be derived. The empirical analysis for that purpose will be based on panel data analysis.

We thus get new insights into the regional production and regional/interregional trade analysis in the ICT sector and it will also be possible to get information on the relative role of Asian sub-regions for trade with the EU and the US, respectively. The analysis proceeds as follows: section (2) presents techno-globalization in Asia based on the trade channel approach. Then, empirical analysis on the determinant of R&D activities of US subsidiaries in Asian ICT production is discussed in section (3). Lastly, section (4) presents policy conclusion.

2. Techno-globalization in Asia based on Trade Channel Approach

In this sub-chapter, the authors present several indicators that proxy techno-globalization through the trade channel. Firstly, it is important to know the general trade pattern of Asian regions with other regions. Thus, the flows of merchandise exports among 5 (five) regions, namely Southeast Asia, East Asia, South Asia, EU27 (European Union) and North America is presented in Table 3.1.

Table 3.1 shows that there is a decreasing trend in the share of intra-region trade within the greater Asia region, except for Southeast Asia. If two periods are considered, the share of intra-region trade dropped by 0.4 to 7.1 percentage points in 2013 relative to 2005. As regards East Asia and South Asia, even though there was a decrease in the share of intra-region trade it is small in magnitude, only 0.4 percent. Unlike other regions, the share of

intra-region trade of Southeast Asia increased from 25.3 percent in 2005 to 27.2 percent in 2013. One of the factors causing the increase in Southeast Asian intra-region trade is the full implementation of the ASEAN Free Trade Agreement (AFTA) by all ASEAN Member States.

If we consider inter-region trade between Asian regions, the share of trade flows between East Asia and Southeast Asia and between South Asia and Southeast Asia increased in 2013 relative to 2007. These are mainly due to the implementation of ASEAN-Korea Free Trade Agreement (AKFTA) in 2007, ASEAN-Japan Comprehensive Economic Partnership (AJCEP) in 2008, ASEAN-China FTA (ACFTA) in 2010, and ASEAN-India FTA (AIFTA) in 2011. Important to note, however, is that not all ASEAN Member States have started to implement FTAs at the same time. As an example, 6 (six) ASEAN Member States (Indonesia, Malaysia, Thailand, Singapore, Brunei, and the Philippines) had to eliminate tariffs on 90 percent of their products from 2010 under ASEAN-China FTA, while CMLV countries (Cambodia, Myanmar, Lao PDR, and Vietnam) have to eliminate their tariffs by 2015. Thus, it is expected that the share may increase further in the coming years.

Table 1: Trade flows among regions (% to total merchandise exports)

2005		Reporter				
		Southeast Asia	East Asia	South Asia	EU27	North America
Partner	Southeast Asia	25.3%	9.5%	8.3%	1.4%	4.2%
	East Asia	29.6%	31.0%	13.5%	4.3%	12.8%
	South Asia	3.2%	1.7%	4.5%	0.9%	0.8%
	EU27	12.8%	17.0%	25.6%	66.7%	16.4%
	North America	15.2%	22.3%	20.4%	8.7%	41.2%
	ROW	13.8%	18.6%	27.8%	18.1%	24.6%
2013		Reporter				
		Southeast Asia	East Asia	South Asia	EU27	North America
Partner	Southeast Asia	27.2%	12.5%	10.6%	1.8%	3.9%
	East Asia	33.8%	30.6%	12.6%	6.2%	15.3%
	South Asia	4.7%	2.8%	4.1%	1.0%	1.3%
	EU27	10.1%	13.1%	17.9%	60.9%	13.8%
	North America	10.3%	17.4%	13.8%	7.2%	34.1%
	ROW	13.8%	23.5%	41.0%	22.9%	31.6%

Source: Author calculation based on WITS database

Southeast Asia experienced an increase in their intra-region trade share relative to total merchandise trade by as much as 1.9 percentage points. The same trend can also be found in the share of the trade flows between Southeast Asia and other Asian region. These imply that Southeast Asia plays an important role in the integration process in Asia. Even though the economic size of countries in Southeast Asia region is varied, all countries in this region are open and actively involved in the trade integration process. As an example, the initation of the Regional Comprehensive Economic Partnership (RCEP) that has been negotiated between 10 ASEAN Member States and 6 other countries, namely China, Japan, South Korea, Australia, New Zealand, and India since 2012.

Trade flows of Asian countries are biased to its regions. The share of inter-region trade of Southeast Asia, East Asia and South Asia to non-Asian regions (European Union and North America) decreased over time. In 2013, the share of inter-region trade between South Asia and non-Asian regions decreased significantly relative to its level in 2005 - as

much as 7.7 percent with the EU27 and 6.6 percent with North America. The same pattern is also found in other Asian regions albeit with smaller magnitudes.

As mentioned in the introduction, trade in intermediate products is increasingly important. Table 3.2 shows the composition of trade in intermediate products among regions. Similar to the trade flows of total products, the share of intra-region trade in intermediate goods in 2013 decreased in almost all regions relative to 2005 except for South Asia. Even though, South Asia experienced an increased in their intra-region trade the magnitude was small,just 0.2 percent.

Table 2: Intermediate goods trade among regions (% to total intermediate goods exports)

2005		Reporter				
		Southeast Asia	East Asia	South Asia	EU27	North America
Partner	Southeast Asia	27.2%	13.2%	10.6%	1.8%	5.0%
	East Asia	34.4%	38.8%	24.1%	4.5%	13.4%
	South Asia	3.9%	2.2%	5.5%	1.2%	0.8%
	EU27	11.5%	12.8%	18.4%	67.3%	15.7%
	North America	9.8%	15.9%	13.9%	8.1%	41.1%
	ROW	13.2%	17.1%	27.4%	17.1%	24.1%
2013		Reporter				
		Southeast Asia	East Asia	South Asia	EU27	North America
Partner	Southeast Asia	24.9%	15.1%	9.6%	1.9%	4.4%
	East Asia	40.7%	36.3%	21.3%	6.1%	17.6%
	South Asia	5.8%	3.9%	5.7%	1.3%	1.4%
	EU27	7.9%	10.3%	16.6%	62.3%	12.5%
	North America	6.6%	12.8%	13.3%	6.4%	34.6%
	ROW	14.1%	21.6%	33.4%	22.0%	29.5%

Source: Author calculation based on WITS database

Free trade agreements between ASEAN Member States and other Asian countries (AKFTA, AJCEP, ACFTA, and AIFTA) has changed the composition of inter-region trade in intermediate products in the Southeast Asia region. The trade flows in intermediate goods of Southeast Asia seem to be biased towards the Asian region. The share of inter-region trade in intermediate products between Southeast Asia and East Asia increased from 34.4 percent in 2005 to 40.7 percent in 2013. On the contrary, the share of inter-region trade in intermediate products between Southeast Asia and the EU27 decreased from 11.5 percent in 2005 to 7.9 percent in 2013.

The increasing share of intra-region trade and inter-region trade in intermediate products for Southeast Asia is strongly related to the development of regional value chains (RVCs). The ASEAN Investment Report 2013-2014 shows the development of RVCs within Southeast Asia and between Southeast Asia and other Asian regions. ASEAN (2014) suggests that one of the drivers of the development of RVCs in the Southeast Asia is Foreign Direct Investment (FDI) flows both within the region and between Southeast Asia and other Asian regions.

The pattern of trade in intermediate products for South Asia is completely different than that for other Asian regions. Intra-region trade within the South Asia region increased and inter-region trade in intermediate products between South Asia and other Asian regions decreased. On the contrary, the share of inter-region trade in intermediate products

between South Asia and the Rest of the World (ROW) increased substantially from 27.4 percent in 2005 to 33.4 percent in 2013.

Previous statistics show the pattern of trade both in final products and intermediate products. Figure 3.1 shows trade intensity (trade bias) amongst East Asia, Southeast Asia, South Asia, EU27 and North America. Trade intensity is the ratio of a trading partner's share to a region's total trade and the share of world trade with the same trading partner. The formula of trade intensity is calculated based on standard trade indicators in the UN-Comtrade, hence:

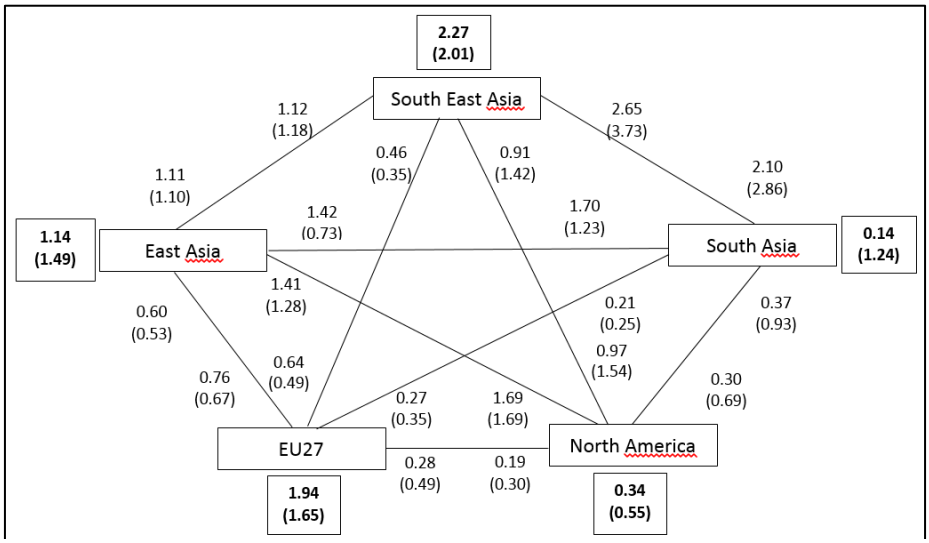
(1) Region i's intraregional trade intensity = $(T_{ii} / T_i)/(T_i / T_W)$

(2) Region i's trade bias toward region j = $(T_{ij} / T_i)/(T_j / T_W)$

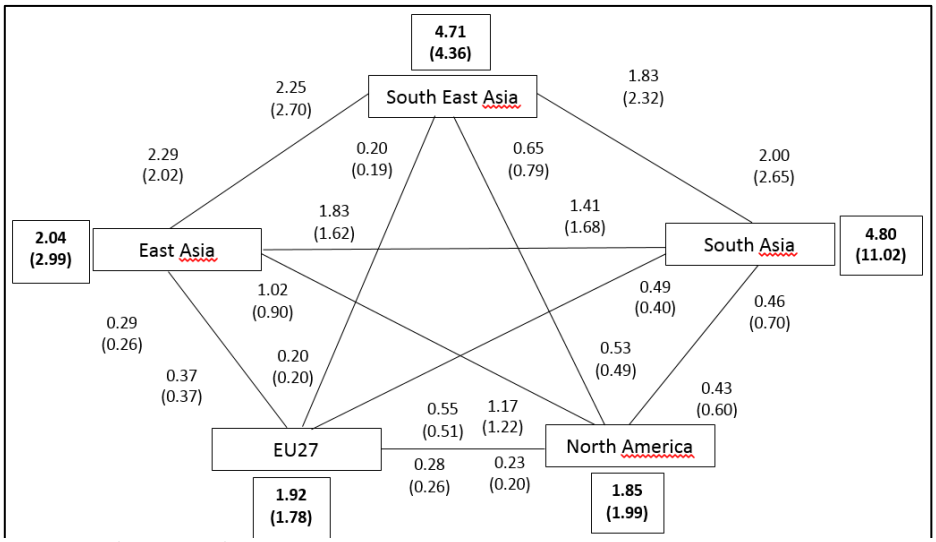
Where T_{ii} represents exports of region i to region i plus imports of region i from region i; T_{ij} represents exports of region i to region j plus exports of region j to region i plus imports of region i from region j plus imports of region j from region i; T_i represents total exports of region i to the world plus total import of region i from the world; T_j represents total exports of region j to the world plus total import of region j from the world; and T_w represents total world exports plus imports.

Figure 3.1 shows the trade intensity index of six Information and Communication Technology sub-sectors. Those six sectors are manufature of office, accounting and computing machinery (MOAC); manufacture of insulated wire and cable (MIWC); manufacture of electronic valves and tubes and other electronic components (MEVT); manufacture of television and radio transmitters and apparatus for line telephony and line telegraph (MTRT); manufacture of television and radio receivers, sound, video recording or reproducing apparatus (MTRV); and manufacture of optical instruments and photographic equipment (MOPE).

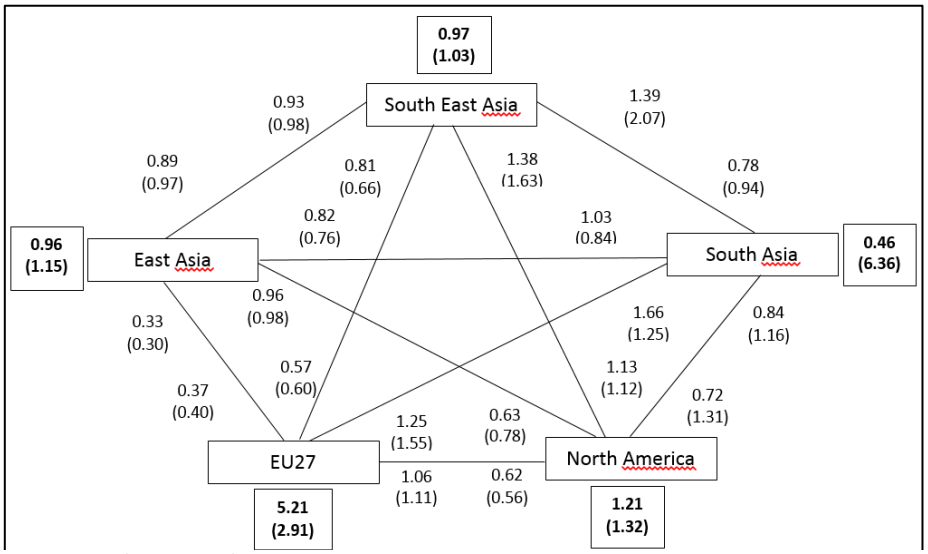
Figure 1: Trade intensity of ICT sub-sectors



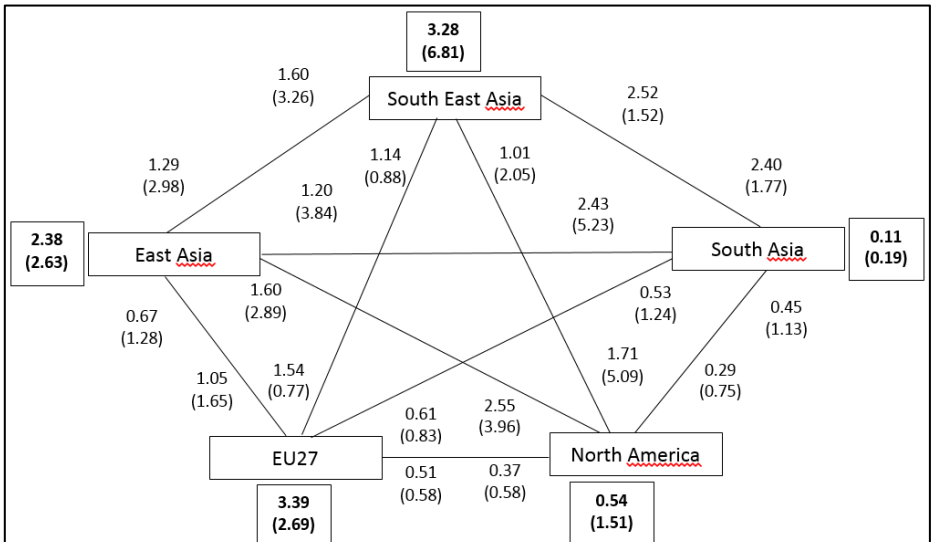
(i) Manufacture of office, accounting, and computing machinery



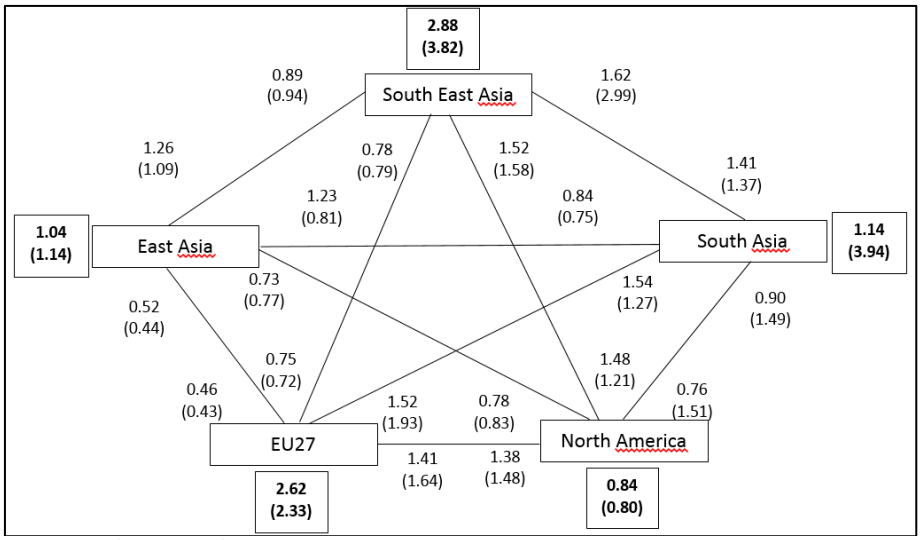
(ii) Manufacture of insulated wire and cable



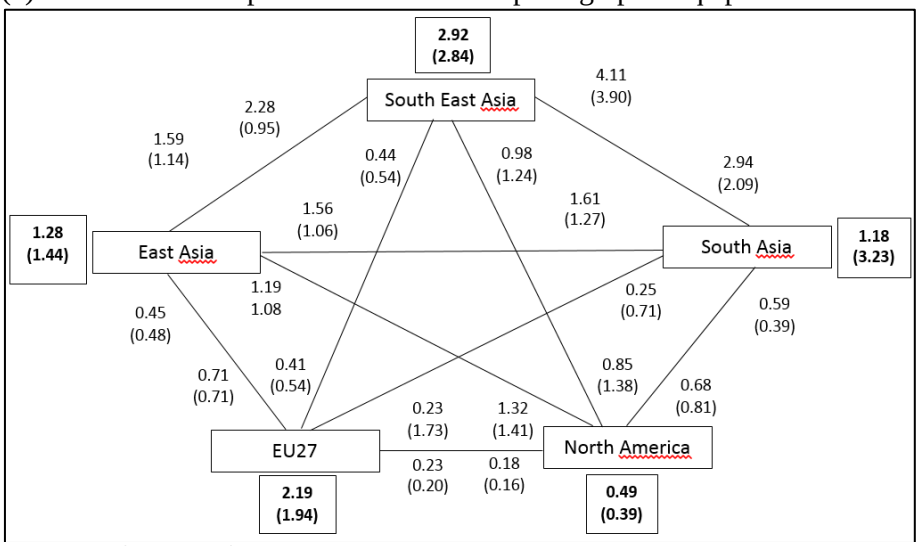
(iii) Manufacture of electronic valves and tubes and other electronic component



(iv) Manufacture of television and radio transmitters and apparatus for line telephony and line telegraph



(v) Manufacture of optical instruments and photographic equipment



(vi) Manufacture of television and radio receivers, sound, video recording or reproducing apparatus

Note: Numbers indicate trade bias in 2013 and 2005 (in parantheses); Values in bold type are the intra-subregional trade bias indices, Values along the lines are the inter-subregional trade bias indices.

Source: author calculation based on WITS Database

Trade in all ICT sub-sectors of Southeast Asia seems to be biased towards intra-region trade except for the manufacture of electronic valves and tubes and other electronic components (MEVT). An intra-subregional trade bias index of Southeast Asia in 5 (five) ICT sub-sectors (MOAC, MIWC, MTRT, MTRV and MOPE) is larger than 2, meaning its intra-subregional intensity is more than twice as high as it is globally. The pattern is basically in line with the trade flows of final products as shown in Table 3.1.

Intra-subregional intensity of South Asia is weak except for the manufacture of insulated wire and cable (MIWC). The trade intensity index of MIWC in South Asia is large in magnitude and even the largest relative to the other Asian regions. One of the biggest producers of insulated wire and cable in the world, Von Roll, established a joint venture company (Pearl Insulations Ltd.) in India. The company is the market leader in producing enameled round and flat wires insulated with glass, known as Daglass, polymide film, as Kapton, and mica tapes or Nomex.

Trade linkages in the ICT products between Southeast Asia and other Asian regions is strong in 5 ICT sub-sectors, namely MOAC, MIWC, MTRT, MTRV and MOPE. The ASEAN Investment Report 2013-2014 shows the increasing trend in the FDI flows to Southeast Asia both from intra-region investment and extra-region investment. More than half of FDI inflows in Southeast Asia is originating from other Asian countries, with the largest single country investor being Japan. The pattern in FDI flows is also shaped by the inter-region trade between Southeast Asian countries and its partner.

As regards trade linkages between Asian and non-Asian regions, one may consider an inter-region trade intensity index in particular sectors and across regions. There are several important findings that we could address from the statistics. Firstly, East Asia is more connected to North America than the European Union in terms of trade in the ICT products. The trade intensity index between East Asia and the European Union is strong (i.e., larger than one) only in MTRT, whereas trade linkages between East Asia and North America are strong in MOAC, MIWC, MTRT, and MTRV.

Secondly, Southeast Asia is also more connected to North America in terms of trade in the ICT products. As regards inter-region trade between Southeast Asia and North America, there are 3 ICT sub-sectors that have a trade intensity index larger than 1 (one), namely MEVT, MTRT, and MOPE. Meanwhile, only one ICT sub-sector that has trade intensity index larger than one, namely MTRT. Thirdly, South Asia seems to be more connected to the European Union relative to North America. There are two ICT sub-sectors that have an inter-region trade intensity index larger than one, namely MEVT and MOPE.

The trade intensity index of several ICT sub-sectors may give us detailed information but lead to mixed conclusions about the pattern of ICT trade among regions in Asia. Table 3.3 shows the trade intensity index for ICT sector in aggregate. It is basically the same indicator as shown in Figure 3.1 but using aggregate data. In general, the indicators suggest that trade in the ICT products for Southeast Asia is generally biased towards intra-regional trade. Moreover, Southeast Asia is also more connected to the Asian region rather than to non-Asian regions in terms of trade in ICT products.

East Asia is not only strongly connected to its region and East Asia, but also has a strong link with North America. The magnitude of the inter-region trade intensity index of East Asia and North America is larger than one, whereas the index of East Asia and South Asia is smaller than one. Another interesting finding can be found in South Asia where the trade intensity indices of South Asia and non-Asian regions are less than 1 (one).

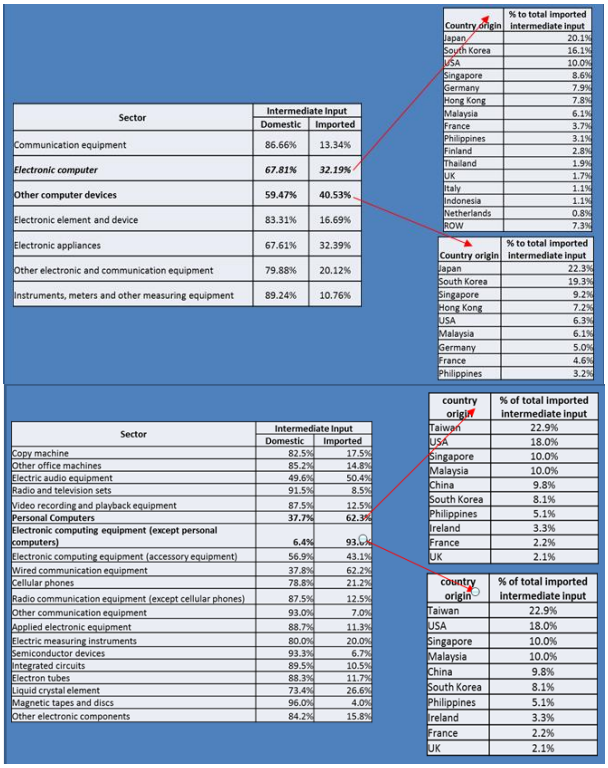
Table 3: Trade intensity if ICT sector (aggregate)

	2013					2005				
	South East Asia	East Asia	South Asia	EU27	North America	South East Asia	East Asia	South Asia	EU27	North America
South East Asia	**1,63**	**1,05**	**1,56**	**0,51**	**0,88**	**1,81**	**1,11**	**1,78**	**0,42**	**1,30**
Indonesia	2,08	1,09	2,56	0,54	0,69	2,58	0,71	1,24	0,68	1,10
Malaysia	1,79	0,95	1,48	0,53	1,14	1,65	0,97	1,54	0,45	1,87
Singapore	1,72	1,10	1,74	0,33	0,64	2,11	1,08	2,63	0,38	0,94
Thailand	1,47	1,09	0,86	0,54	1,34	1,44	1,43	0,96	0,38	1,20
Vietnam	1,05	1,07	2,13	0,95	0,48	2,15	1,58	0,53	0,31	0,40
East Asia	**1,04**	**1,17**	**0,96**	**0,43**	**1,04**	**1,09**	**1,39**	**1,00**	**0,44**	**1,09**
China	0,94	1,02	1,37	0,54	1,27	1,01	1,28	1,21	0,50	1,21
Hong Kong, China	1,31	1,56	0,10	0,12	0,35	1,30	1,95	0,14	0,14	0,40
Japan	1,10	1,35	0,27	0,31	0,90	1,26	1,29	0,34	0,45	1,26
Korea, Rep.	1,11	1,28	0,62	0,38	0,90	0,89	1,37	2,07	0,53	1,12
South Asia	**1,28**	**1,33**	**0,51**	**0,47**	**0,47**	**1,27**	**1,35**	**1,51**	**0,67**	**0,80**
India	1,32	1,31	0,38	0,48	0,47	1,42	1,48	0,98	0,47	0,84
Pakistan	0,55	1,78	0,09	0,29	0,42	0,45	0,81	0,14	1,50	0,78
Sri Lanka	1,44	1,30	6,87	0,50	0,40	1,99	0,77	14,41	0,85	0,58
EU27	**0,54**	**0,56**	**0,48**	**2,64**	**0,44**	**0,46**	**0,58**	**0,71**	**1,92**	**0,51**
France	0,72	0,73	0,67	2,04	0,45	0,50	0,72	1,30	1,72	0,52
Germany	0,74	0,66	0,65	2,26	0,56	0,58	0,73	0,82	1,70	0,50
Netherlands	0,61	0,56	0,38	2,62	0,37	0,65	0,59	0,20	1,80	0,58
United Kingdom	0,49	0,58	0,57	2,61	0,71	0,43	0,51	0,63	1,84	0,70
North America	**0,89**	**1,22**	**0,39**	**0,33**	**0,57**	**1,31**	**1,32**	**0,67**	**0,35**	**0,74**
Canada	0,49	0,95	0,22	2,90	0,28	0,61	0,86	0,36	0,24	3,41
United States	0,94	1,25	0,41	0,33	0,31	1,39	1,37	0,71	0,36	0,42

Source: Author calculation based on WITS database

The trade intensity index in both the ICT sub-sectors and ICT sector suggests that East Asia is more connected to North America than the European Union. In order to get supporting evidence, this study also considered the detailed trade (transactions) across sectors and countries. Figure 3.2 shows the consumption of intermediate inputs in the Chinese and Japanese ICT sectors. Even though the main source of imported intermediate inputs for the production in the Chinese and Japanese ICT sector is originating from other Asian countries, the United States still plays an important role as the main supplier among non-Asian countries.

Figure 2: Linkages among ICT sectors in China and Japan and their trade partners



Sector	Intermediate Input	
	Domestic	Imported
Communication equipment	86.66%	13.34%
Electronic computer	***67.81%***	***32.19%***
Other computer devices	**59.47%**	**40.53%**
Electronic element and device	83.31%	16.69%
Electronic appliances	67.61%	32.39%
Other electronic and communication equipment	79.88%	20.12%
Instruments, meters and other measuring equipment	89.24%	10.76%

Country origin	% to total imported intermediate input
Japan	20.1%
South Korea	16.1%
USA	10.0%
Singapore	8.6%
Germany	7.9%
Hong Kong	7.8%
Malaysia	6.1%
France	3.7%
Philippines	3.1%
Finland	2.8%
Thailand	1.9%
UK	1.7%
Italy	1.1%
Indonesia	1.1%
Netherlands	0.8%
ROW	7.3%

Country origin	% to total imported intermediate input
Japan	22.3%
South Korea	19.3%
Singapore	9.2%
Hong Kong	7.2%
USA	6.3%
Malaysia	6.1%
Germany	5.0%
France	4.6%
Philippines	3.2%

Sector	Intermediate Input	
	Domestic	Imported
Copy machine	82.5%	17.5%
Other office machines	85.2%	14.8%
Electric audio equipment	49.6%	50.4%
Radio and television sets	91.5%	8.5%
Video recording and playback equipment	87.5%	12.5%
Personal Computers	**37.7%**	**62.3%**
Electronic computing equipment (except personal computers)	**6.4%**	**93.6%**
Electronic computing equipment (accessory equipment)	56.9%	43.1%
Wired communication equipment	37.8%	62.2%
Cellular phones	78.8%	21.2%
Radio communication equipment (except cellular phones)	87.5%	12.5%
Other communication equipment	93.0%	7.0%
Applied electronic equipment	88.7%	11.3%
Electric measuring instruments	80.0%	20.0%
Semiconductor devices	93.3%	6.7%
Integrated circuits	89.5%	10.5%
Electron tubes	88.3%	11.7%
Liquid crystal element	73.4%	26.6%
Magnetic tapes and discs	96.0%	4.0%
Other electronic components	84.2%	15.8%

country origin	% of total imported intermediate input
Taiwan	22.9%
USA	18.0%
Singapore	10.0%
Malaysia	10.0%
China	9.8%
South Korea	8.1%
Philippines	5.1%
Ireland	3.3%
France	2.2%
UK	2.1%

country origin	% of total imported intermediate input
Taiwan	22.9%
USA	18.0%
Singapore	10.0%
Malaysia	10.0%
China	9.8%
South Korea	8.1%
Philippines	5.1%
Ireland	3.3%
France	2.2%
UK	2.1%

Source: Author calculation based on EORA-MRIO Database

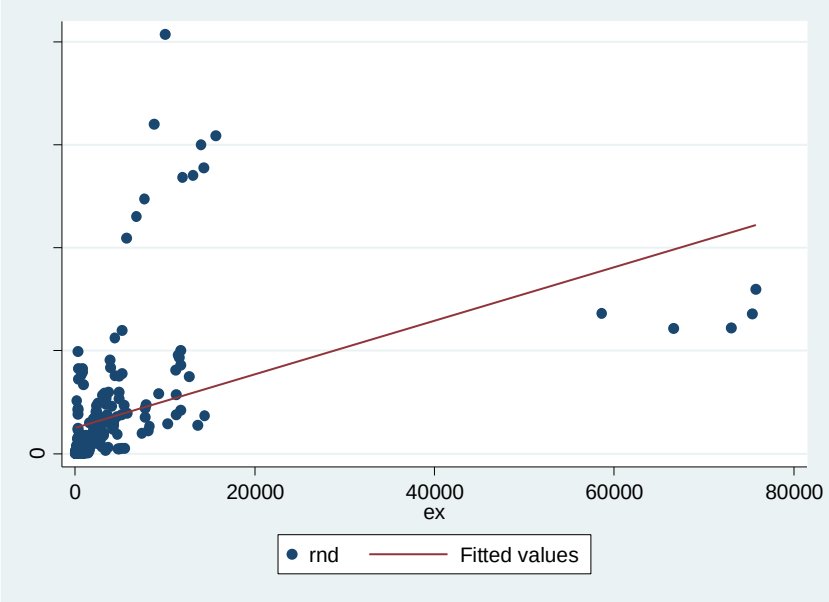
3. The Determinants of MNEs R&D Activities in the Host Countries

Chapter 3 presents an empirical analysis on the determinants of R&D expenditure by multinational enterprises (MNEs). In this study, we focus our analysis on the R&D activities of USA MNEs abroad. MNEs from the United States play an important role in the global R&D activities. Based on Grueber et al. (2013), MNEs from the US are still at the top of the list as measured by R&D spending. MNEs from the US have the largest share in the total global R&D spending, as much as 34.5 percent in 2012. The share slowly decreased to 34 percent in 2013 and is expected to drop further to 33.9 percent in 2014. This is mainly due to the slow economic recovery in the United States. A similar decreasing trend is also found in the share of MNEs from the European Union to total global R&D spending, from 23.1 percent in 2012 to 21.7 percent in 2014.

Asian countries also play a significant role in the global R&D activities. In total, the share of Asia in the total global R&D spending reached 37 percent in 2012 and is predicted to increase up to 39.1 percent in 2014 (Grueber et al., 2013). China and Japan are the two countries that contributed the most with a combined share of as much as 25.8 percent in 2012. Even though China is not the largest contributor of global R&D spending, the growth of Chinese R&D spending is really strong. Grueber et al. (2013) predicted that the share of Chinese R&D spending to the total world R&D spending will increase by 2.2 percent in two years, reaching a new record of as much as 17.5 percent in 2014.

In order to understand the determinant of R&D activities of MNEs, this study conducts an empirical analysis on the R&D data of the US MNEs. By using a panel data method, R&D spending of MNEs is modeled to be determined by output (proxied by sales), capital expenditure, and trade (proxied by exports). Then, in order to quantify the effect of location, two dummy variables are created, representing European Union countries (EUR) and Asian countries (ASIA). All the data is collected from the BEA Database. The size of the MNEs is a common R&D determinant in the literature. Becker (2013) mentioned size as part of firm characteristics. Liu (2011), Harmantzis and Tanguturi (2005), Bean (1995), Ito and Pucik (1993) used sales as the proxy for firms size. As regards capital expenditure, Harmantzis and Tanguturi (2005) argue that R&D should be capitalized and not treating as an operating expense. Thus, capital expenditure is expected to move directionally together with R&D spending. In this study, we add an additional variable in the R&D spending function. It is expected that exports are positively correlated with R&D spending since the observation that is used in the empirical analysis is MNEs. A simple scatter plot between those two variables, as shown in Figure 3.3, supports the hypothesis. There is a positive slope in the fitted values between exports and R&D spending.

Figure 3: Scatter plot R&D spending and exports of MNEs



After considering several indicators, such as a heteroskedasticity test, an autocorrelation test, and a Hausmann test, the study concludes that the random model is the most appropriate estimation. Table 3.4 shows the estimation results of the R&D spending model. In general, the results suggest that the size of MNEs is positive and strongly correlated with the R&D spending. Larger MNEs tend to spend more on the R&D activities. Moreover, the role of the MNEs in the global trade is also positive and statistically significant. This means that the increasing role of MNEs in the global market will give them an incentive to spend more on R&D activities.

Table 4: Estimation results of panel data method

	fixed b/se	random b/se	random1 b/se	random2 b/se	random3 b/se
SALES	1.227**	1.229***	1.220***	1.168***	1.169***
	(0.169)	(0.155)	(0.155)	(0.157)	(0.157)
CAPITAL EXPEND.	0.039	0.018	0.020	0.034	0.035
	(0.121)	(0.112)	(0.113)	(0.112)	(0.112)
EXPORT	0.213**	0.138	0.149*	0.172*	0.169*
	(0.098)	(0.088)	(0.089)	(0.089)	(0.090)
ASIA			-0.248		0.166
			(0.393)		(0.435)
EUR				0.686**	0.757*
				(0.336)	(0.388)
CONSTANT	-9.680***	-9.016***	-8.955***	-9.023***	-9.083***
	(1.174)	(0.977)	(0.986)	(0.967)	(0.979)
R-squared	0.507				
N	215	215	215	215	215

* p<0.10, ** p<0.05, *** p<0.01

As regards the dummy variables, the results suggest that only EUR is statisically significant and positively affects the R&D spending. The dummy for Asian countries is not statistically significant, meaning Asian countries are less attractive than European countries as R&D host countries. The insignificance of the dummy variable for Asian countries raises several important points. Firstly, a relatively weak trade linkage both in final products and intermediate products between Asian countries and the United States may lead to the disincentive of MNEs from the US to conduct R&D activities in the Asian

countries. Secondly, the possible role played by the level of human resources in Asian countries which is relatively less qualified than the one in European countries. Thirdly, the research network between indutries, government and universities in Asian countries is not as advanced as the research network in the European countries. This location aspect is an important variable that will attract more R&D spending of firms (Becker, 2013).

Taking into account the analysis of the ADB (2015), one may point out that Asian economic and innovation dynamics are asymmetric, namely with East Asia, including China, becoming part of the international value-added chains and also of some R&D networking (e.g., with IBM, SIEMENS and SAP having software labs in many Asian countries). With wage costs in China rising in the wake of a peak of labor supply in China in 2014, there will be long-term pressure for enhanced Asian production sharing through Chinese regional outsourcing and off-shoring. Asian foreign direct investment is increasingly focussed on Asia and intra-Asian trade is also growing strongly. With China's foreign direct investment predominantly flowing to other Asian countries, one may assume that many Chinese firms are increasingly using intermediate inputs from other Asian countries; the source of intermediate inputs thus will often be Chinesese subsidiaries abroad or foreign intermediate goods producers from Japan, Korea and Singapore. Even if the share of intermediate products in China's export production has continued to increase in the first half of the first decade of the 21st century, one cannot easily argue that Chinese firms have become more dependent on foreign supplies since the technology level of intermediate products imported has not consistently increased – rather Chinese firms have used the freeing of domestic inputs through international outsourcing and offshoring to move up the technology ladder in Chinese value-added. Chinese firms facing rising wage pressures in the home market – on the back of high economic growth - try to organize international value-added chains in which Asian suppliers produce low-technology and intermediate technology intermediate inputs for the rising number of Chinese high-technology firms. European firms participate in these dynamics largely through FDI in China and some other Asian countries. Since US, Japanese and EU firms in certain sectors often compete in an oligopolistic global setting, the move of one of the western and Japanese industry leaders to China could trigger further FDI from competitors in other OECD countries. This could not only strongly contribute to high FDI inflows into China and other East Asian countries, but it should also contribute to enhanced international technology flows towards leading Asian countries.

4. Policy Conclusions

There is a clear subdivision of interregional trade links, namely that the US is mainly linked to South East Asia and East Asia while the EU trade links are relatively strong with South Asia. This indicates that the US trade links with Asia in ICT are fairly strong while the EU has a rather limited role in Asia. For Asian host countries, the competition between the USA and the EU is certainly welcome; additionally, in many host countries in these three regions Japanese ICT firms are active as well. To the extent that the US trade liberalization resulting from the Trans-Pacific Partnership (TPP) should be completed fairly soon, the US firms in Asia will face additional incentives to produce in Asia. By

contrast, the EU only has a trade liberalization treaty with Singapore and is currently negotiating with several more Asian countries, but this certainly is a more modest liberalization initiative that the US-Asia project TPP. However, given regional population, trade and innovation dynamics in Asia, one may argue that ICT sector expansion in Asia should indeed be expected to continue since removing trade barriers between Asia and the US will create new investment opportunities in many Asian countries. At the same time, the overall strong regional expansion of ICT on the back of strong regional Asian and in particular Chinese economic growth will contribute to new expansion opportunities for ICT investors in Asia. An obvious endogenous link concerns the fact that the share of ICT investment in total investment in both OECD countries and Asian countries is rising over time so that a rising capital intensity in the course of economic catching-up in Asia will often go along with higher ICT inputs in the production process. To the extent that static and dynamic economies of scale in ICT production can often be combined with fairly low Asian unit labor costs in the production of ICT goods, it would not be surprising to witness that US foreign investors who are already successfully producing in some Asian countries will continue to seek an optimal exploitation of the regional intermediate inputs in leading technology fields.

The highly innovative ICT sector shows in the case of Asia that US firms are stronger engaged in Asian countries when compared to EU firms. It is not clear a priori that distance matters for explaining this finding. There is a modernized railway link between Germany and China that allows to build up just-in-time production in Asia in a very reliable way, however, this logistical advantage has so far not been exploited strongly with respect to EU ICT investment in China. As regards intellectual property rights issues, firms from the US probably enjoy more support from its government vis-à-vis China than German (or French) firms enjoy on the basis of the German (or French) government's support in China. The EU, in the form of the European Commission, is clearly not considered to be a strong institution in many Asian countries.

The European Commission has emphasized ICT dynamics as one element of a broader modernization strategy focusing on selected lead markets. One may argue that the focus on ICT is adequate with respect to the aim of achieving higher economic growth. However, it seems that the European Commission has not explicitly considered combining trade liberalization approaches – particular with respect to Asian countries – and innovation promotion policy.

A particular problem of the European Union in the field of ICT innovation and investment dynamics is that the political system works much too slowly to really exploit new investment and trading opportunities in an optimal way. A typical "Green Paper" on a new policy topic takes 1 ½ years to complete and the following, more advanced, "White Paper" will roughly absorb the same amount of time; another two years will be needed for achieving a so-called Directive which sets the framework within which EU member countries then take another two years to implement national legislation. In a world economy with fast economic globalization and rapid ICT innovation dynamics, respectively, it seems that such slow adjustment in the parliamentary process in the EU is definitively much too slow to keep pace with the US. In the US, the Congress and the president have shown on various occasions – e.g., during the banking crisis – that the system is much faster in addressing serious new policy challenges than is the case in the EU. Facing ongoing negotiations with the US on the project of a Transatlantic Trade and

Investment Partnership, one may assume that the European Commission and the European Parliament will adopt measures to accelerate legislation in the EU in critical fields

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