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ORIGINAL PAPER

Technological intensity in manufacturing trade between ASEAN and the EU: challenges and opportunities

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Abstract

This article analyses trade flows EU-ASEAN, focusing on export performance and technological intensity, covering the years 2004–2016. The aim of this paper is to analyse to what extent, a further trade integration between the EU and ASEAN, could generate business opportunities for countries in both trading blocs. This analysis could serve as a basis for designing and implementing effective policies and strategies by policymakers in the face of a deepening EU-ASEAN trade integration. Therefore, a detailed analysis of the degree of complementarity of trade patterns, the weight of intra-industry trade, and the revealed comparative advantages allows us to outline some of those challenges and opportunities. Results suggest that intra-industry trade is moderate, mainly focused on few manufactures, accounting for a low value of total trade flows between the two blocs, and concentrated in a few countries. The Lafay index analysis suggests that the EU and ASEAN are natural partners regarding the technological patterns of the revealed comparative advantages; therefore, a deepening in trade integration between this trading blocs could allow to exploit those comparative advantages.

Introduction

The Association of Southeast Asian Nations (ASEAN) and the European Union[1] (EU) are two of the world largest trading blocs, which play a crucial role in global manufacturing trade. In 2016, according to UNCTADstat database of the United Nations Conference on Trade and Development (UNCTAD), ASEAN accounted for

[1] The UK is included as part of the EU because it was a member state during the period covered by the research. However, it is convenient to note that since the UK is no longer a member state of the EU, in the face of a potential EU-ASEAN free trade agreement, the results of the analysis carried out in this research would not largely cover the UK once disengaged from the EU.

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7% of world trade in manufactured goods, and 8% of world trade in high-skill and technology-intensive manufactures, while figures for the EU were 37% and 33%, respectively.

In 2007, the European Commission and ASEAN launched negotiations to achieve a free trade agreement (FTA), but in 2009 due to lack of progress, both sides agreed to stall negotiations. Therefore, in December 2009, the EU Council of Ministers allowed the European Commission to pursue negotiations towards bilateral FTA with individual ASEAN member states; as a result, FTA with Singapore and Vietnam were concluded, but they have not yet been ratified.

A deepening in trade integration between trading blocs could generate diverse macroeconomic and microeconomic effects depending on economic structures prevailing in member states. Among underlying factors causing these likely effects include the role of external sector over the total output, the volume of exports in relative terms by sectors involved in bilateral negotiations, the comparative and competitive advantages of traded manufactures, size of the exporting economy, the role of offshoring and global value chains (GVCs) in bilateral trade, investment flows between potential partners, financial openness, etc. (Krugman and Venables 1996; Rivero 2005; Kang 2011). Even though the different level of economic and social development between the two trading blocs is clear, it is worth noting the differences in internal harmonisation in both blocs. Unlike in the case of ASEAN, in the process of European unification, emphasis has been placed on the implementation of internal cohesion policies, which can minimise the negative effects of asymmetries in the effects that a free trade agreement can have on the member countries of both blocs. Furthermore, the different degree of internal harmonisation could lead to asymmetries in relation to ASEAN's bargaining power (Devadason and Mubarik, 2020).

While many analyses have tried to quantify gains derived from trade openness (Costinot and Rodriguez-Clare 2013) and from trade agreements (Berlingieri et al. 2018), in recent years, particular emphasis has been placed on the analysis of manufacturing exports from the technological intensity standpoint, paying attention to what is exported rather than how much is exported. Recent analyses focus on long-term economic growth in developing countries have shown the importance of export quality (Hausmann et al. 2007), and diversification in new products (Hummels and Klenow 2005). International economic institutions such as UNCTAD, the United Nations Industrial Development Organization (UNIDO), the World Trade Organization (WTO), and the International Trade Center (ITC) have placed the emphasis in developing the capacity of countries to improve technological export pattern, since the manufacturing activities that incorporate a greater technological intensity in their production account for a remarkable contribution to total factor productivity growth. Moreover, those manufacturing activities arouse a greater contribution to total value-added growth, with significant linkages to ensure spillover effects, knowledge building, and significant implications in nation branding (Ortin and Vendrell-Herrero 2014; Qian and Qian 2012).

In this context, it is relevant to analyse to what extent a deeper trade integration between the EU and ASEAN could generate business opportunities for countries in both trading blocs. This analysis is carried out from the technological intensity

perspective, disaggregating exports according to technological content to determine whether there is complementarity between trade patterns, and consequently to conclude in which technological segments trading blocs are natural partners. To fully achieve this task, we use appropriate and generally accepted indices to compute weight of intra-industry trade, and main revealed comparative advantages of manufactured goods traded between ASEAN and the EU, during the study period 2004–2016. Primary data sources are the United Nations 'UN Comtrade' database and 'UNCTADstat'. Classification of manufactured goods established by the UNCTAD in its 'Trade and Development Report 2002' is used, where manufactures are classified according to the 'Standard International Trade Classification (SITC-Rev.3)'[2]. Based on measures such as the ratio between R&D expenditure and added value, the UNCTAD classification breaks up manufacturing according to its technological intensity and skills into high-skill and technology-intensive manufactures, such as automatic data processing machines, telecommunication equipment, cathode valves and tubes, medicaments, and aircrafts. Medium-skill and technology-intensive manufactures such as electrical circuits, internal combustion piston engines, and motor vehicles. Low-skill and technology-intensive manufactures such as metal containers, motorcycles and cycles, ships, and boats. Furthermore, labour-intensive, and resources-intensive manufactures such as manufactures of leather, textile yarns, furniture, and footwear.[3]

Literature review

Recent research has placed increasing emphasis on bilateral trade EU-ASEAN. Devadason and Mubarik (2020) analysed export flows between the EU and ASEAN and concluded that there is a low level of export efficiency. Moreover, Paderon (2020) studied EU-ASEAN interregional trade indicating that these trading blocs are natural trading partners and should pursue a region-to-region free trade agreement. Andreosso-O'Callaghan and Nicolas (2008) highlighted that the content of potential agreement depends on the nature of trade involved between the two partners, reason why they explore trade relationship EU-ASEAN, concluding there are substantial disparities between the two partners in terms of economic size and internal homogeneity, and strong asymmetry in their trade. Kabir and Salim (2011) analysed EU-ASEAN trade potential by comparing actual trade with estimated potential trade, concluding that there is a substantial undiscovered potential trade between these trading blocs, and a prospect for a higher level of integration success with a *de jure* EU-ASEAN trade integration process. Andreosso-O'Callaghan and Nicolas (2007) studied trade flows in manufacturing goods EU-ASEAN highlighting that the greater the complementary, the higher the scope for trade expansion between the two blocs, the lower the cost induced by resource reallocation, and the more desirable and successful FTA. Andreosso-O'Callaghan and Nicolas (2007) using

[2] https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14

[3] https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14&Top=2&Lg=1

standard complementary, comparative advantages and intra-industry trade indices, concluded that there is high complementarity in manufacturing services between the two regions, pointing out that manufacturing trade EU-ASEAN exhibits low levels of intra-industrial trade, and therefore, the degree of trade complementarity between these two blocs is high, arguing the potential trade gains from freeing trade. Vahalik (2014) compares bilateral trade EU-ASEAN and bilateral trade China-ASEAN, during the period 1995–2012, concluding that since the establishment of the China-ASEAN FTA, trade flows between both partners have increased, with China's exports to ASEAN being the main beneficiaries at the expense of trade flows EU-ASEAN, resulting in a trade diversion. Vahalik (2014) points out that there is greater complementarity between the EU-ASEAN than in the case China-ASEAN, concluding that ASEAN and the EU are better natural partners than China and ASEAN. Geest (2004) stated that for an EU-ASEAN FTA to be worthwhile, it must generate benefits on issues linked to non-tariff barriers to trade, technical standards, sanitary and phytosanitary measures, and mutual recognition arrangements. Other research corroborates the importance in trade gains of having complementarity of trade patterns before FTA is accomplished. Thus, Aslam (2012) stated that in the wake of the China-ASEAN FTA signed in 2002, expectations about possible trade gains in the manufacturing sector were low mainly due to low degree of complementarity in their international trade patterns. On the other hand, the FTA signed between Australia, New Zealand, and ASEAN is more likely to generate trade creation than trade diversion due among other reasons to complementary in trade patterns (Bano et al. 2013). Park et al. (2012) came to similar conclusions regarding the FTA signed between South Korea and ASEAN.

Since Balassa (1965) established the comparative advantage index which carries his name, several different authors have contributed with extended versions of the Balassa index (1965). Bowen (1983) introduced the consumption level into the analysis, and Proudman and Redding (2000) tried to eliminate distortions due to country size by weighing the index to the number of products exported by a country. Yu et al. (2009) introduced the standardised revealed comparative advantage index, which shows the difference in the comparative advantage of a country for each product in a specific market and established comparable ranges of comparative advantages among countries that allow trade patterns to be developed. It is relevant to note that authors such as Palley (2008) extended the traditional definition of the concept of comparative advantage providing a broader meaning. This new approach to the concept of comparative advantage overcomes to some extent the criticisms of authors such as Krugman (1979) who have focused more on aspects such as increasing returns and imperfect competition to explain trade flows. Likewise, Lafay (1992) considered that factors such as innovation at the macroeconomic level in production processes play an important role in determining comparative advantages. Consequently, Lafay (1992) included imports into the analysis, providing an index more in line with the concept of intra-industrial trade. Thus, Alessandrini et al. (2007) observed for India that liberalisation measures were able to improve the comparative advantage in those segments of manufactures with medium and high technological content, and to measure these advantages, the authors used the Lafay index. Ferrarini and Scaramozzino (2015) studied the reasons why the analysis based on the

concept of "product space" has not been given due prominence and applied this concept to the analysis of China's exports, concluding that although China has expanded its trade to products that were typically exported by more advanced countries, added value is still low, and for this purpose, the authors used the Lafay index to determine comparative advantages.

Intra-industry trade analysis was an important challenge to traditional trade theories, since intra-industry analyses assume a type of trade that includes goods with similar factor intensity, and this assumption has no place in neoclassical models, as is the case of the Heckscher–Ohlin model. Therefore, intra-industrial trade refers to a type of market with a certain presence of imperfect competition which facilitates economies of scale, non-homogeneous products, etc. Therefore, among the most controversial and profusely issues studied in recent international trade literature is the measurement of intra-industrial trade. One of the earliest approaches to the measurement of intra-industrial trade was carried out by Grubel and Lloyd (1975). Likewise, the intra-industrial trade index of Grubel–Lloyd has served as the basis for the development of other types of approaches, such as those carried out by Dixit and Stiglitz (1977) and Lancaster (1980), with market structures under monopolistic competition. Greenway et al. (1994) established a new intra-industrial trade index, which differs from the Grubel–Lloyd index mainly in that the measurement of trade is done in absolute terms and not as a ratio, which facilitates the adjustment of intra-industrial trade in relation with the level of gross trade of an industrial sector, which is useful for econometric analysis of those forces that determine the structural adjustment (Brülhart 2002). Notwithstanding the several extensions of the Grubel–Lloyd index, and due to its important empirical refutation, the Grubel and Lloyd index is still one of the most used to measure intra-industry trade. Clark and Stanley (2003) computed the Grubel and Lloyd index to establish the determinants of intra-industrial trade between the United States (USA) and the most industrialised countries, reaching results consistent with the assumptions of the new theories of international trade.

EU-ASEAN trade in manufactured goods

Before going into a substantive assessment of manufactured goods exported between ASEAN and the EU according to their technological content, it is worth noting some key facts about trade in manufactured goods between these two trading blocs. Therefore, Table 1 shows the manufactures exported by each country as a share of GDP, and as a share of total goods exported. Based on the data obtained, in average during the study period, we observe that countries such as Belgium, Slovakia, Hungary, Czechia, Slovenia, Ireland, the Netherlands, Singapore, Vietnam, Thailand, Malaysia, and Cambodia manufactured exports had an important weight on the total output of these economies. Likewise, in most of the countries surveyed, manufactures are the main exported goods, apart from Brunei, Laos, and Myanmar, due in part to a still incipient industrial development.

Table 1 also includes the ratio of manufactured goods that EU countries exported to ASEAN over total manufactured exports, and vice versa, which

Table 1 Exports of manufactured goods as a percentage of GDP, as a percentage of the total value of exports, and as a percentage of bilateral trade (Average 2004–2016)

Country	Manufactured goods exports, percentage of GDP	Manufactured goods exports, percentage of total exports	ASEAN's shares of EU manufacture's exports	Country's share of EU-28 total manufactured exports to the ASEAN
Austria	31.02	80.65	1.15	2.05
Belgium	62.51	70.66	0.86	3.75
Bulgaria	23.33	51.96	0.59	0.10
Croatia	13.55	66.29	0.54	0.06
Cyprus	4.92	53.79	2.87	0.04
Czechia	60.53	88.09	0.46	0.83
Denmark	19.41	61.80	1.53	1.36
Estonia	41.42	64.60	0.25	0.03
Finland	22.76	75.86	1.91	1.51
France	15.80	78.23	2.83	16.76
Germany	31.37	83.07	1.92	30.35
Greece	7.25	41.83	0.76	0.12
Hungary	59.66	82.49	0.69	0.77
Ireland	41.36	84.85	1.94	2.79
Italy	18.58	82.51	1.62	9.26
Latvia	20.22	57.20	0.32	0.02
Lithuania	31.32	56.05	0.17	0.03
Luxembourg	32.16	81.00	0.53	0.12
Malta	24.98	66.05	13.05	0.40
Netherlands	40.03	57.42	1.57	7.56
Poland	27.05	78.40	0.59	1.12
Portugal	17.67	75.51	1.42	0.76
Romania	23.02	77.82	0.31	0.17
Slovakia	65.73	85.64	0.22	0.17
Slovenia	46.69	74.65	0.34	0.11
Spain	13.65	71.68	1.05	2.89
Sweden	24.01	74.79	2.10	3.54
United Kingdom	11.43	67.04	2.98	13.19
EU	**29.68**	**75.34**	**1.71**	**100**
Country	Manufactured goods exports, percentage of GDP	Manufactured goods exports, percentage of total exports	EU's shares of ASEAN manufacture's exports	Country's share of ASEAN total manufactured exports to the EU
Brunei Darussalam	1.93	4.02	9.04	0,10
Cambodia	41.89	89.23	20.98	2.01
Indonesia	9.02	40.66	15.02	9.94
Laos	3.78	23.28	46.13	0.09
Malaysia	54.20	65.90	12.87	18.04
Myanmar	4.03	15.10	31.09	0.38
Philippines	22.12	80.06	15.79	7.08
Singapore	86.02	74.22	11.05	29.05
Thailand	40.84	72.80	12.89	18.20
Vietnam	44.01	62.91	23.03	15.11
ASEAN	**37.12**	**67.01**	**14.12**	**100**

Note: Author's calculation using UNCTADstat data

serves as a trade intensity index between these two partners. As shown in Table 1, Malta, France, Cyprus, Germany, United Kingdom (UK), and Sweden are the EU Member States that allocate a higher percentage of its total manufactured exports to ASEAN countries. Although the analysis of the determinants of export flows is very complex, several determinants have been profusely analysed from both the demand and the supply side, such as the transport cost, labour cost, degree of market opening, investment flows, and aid for trade (Fugazza 2004; Chen et al. 2016; Pettersson and Johansson 2013). Through the analysis of the data, we have observed a high complementarity regarding the export and import patterns of those mentioned EU countries and ASEAN. Thus, during the period of study, 'cathode valves and tubes' were the main manufactures imported by Singapore, the second manufactures most exported by Malta, and the main manufactures exported by Malta to ASEAN, mainly to Singapore. Another example is the case of France whose main manufactures exported to ASEAN were 'cathode valves and tubes' and 'aircraft and associated equipment', two of the main manufactures imported by ASEAN. It is important to emphasise that some of those countries have undertaken agreements with their ASEAN counterparts to deepen collaborative projects in certain strategic areas that may lead to an improvement in trade flows over the mid-term. Thus, France and Singapore have signed in 2012 the France-Singapore Strategic Partnership, also the French Chamber of Commerce in Singapore, established in 1979, it has been a major player in deepening economic relations between the two countries, which launched the initiative French Scientists in Singapore alongside with the French National Center for Scientific Research. Germany, on its side, has implemented many collaboration schemes with ASEAN countries via the German Corporation for International Cooperation, the National Metrology Institute of Germany, and the German state-owned development bank Kreditanstalt für Wiederaufbau. Moreover, Germany has been an active player along with Malaysia in triangular cooperation focus on developing countries in Southeast Asia supporting south-to-south cooperation. Furthermore, UK launched in 2011 the UK-ASEAN Business Council as part of the overall strategy 'Britain Open for Business', and Sweden launched in 2005 the Swedish Strategy for Development Cooperation with Southeast Asian Countries.

On the other hand, Laos is the ASEAN country with the highest percentage of manufactured goods exported to the EU, followed by Cambodia and Myanmar, largely since they are beneficiary countries of the 'Everything but Arms scheme' within the Generalised System of Preferences, which grants to less developed countries free access of tariffs and quotas to the European Single Market for all products, except arms and armaments. Likewise, it is observed that the EU is a key market for the ASEAN companies, since 14% of manufactures exported by the ASEAN reached the EU, whereas the ASEAN market accounts for 1.7% of total manufactures exported by the EU, on average and during the period considered. These figures highlight the low presence of European companies in the ASEAN markets, and together with the analysis of comparative advantages carried out below offers a significant challenge to European companies. In the fifth column of Table 1, the weight of each European country is measured as a percentage of the total value of manufactured exports from the EU to ASEAN, and

vice versa. We note that Germany is the EU country that exports more manufactures to ASEAN, accounting for 30% of all manufactures that the EU exports to the ASEAN, followed by France, UK, Italy, Netherlands, Belgium, Sweden, Ireland, and Spain. Singapore was the ASEAN country that exported the biggest share of ASEAN exports to the EU, accounting for 29%, followed by Malaysia and Thailand. Overall, we can see that there is a low share of total EU exports targeting ASEAN and vice versa, suggesting a low level of regional integration.

Breakdown by technological intensity of the EU-ASEAN trade in manufactured goods

Table 2 provides information on percentage share of manufacturing exports by degree of technological intensity in total manufactures traded by EU-ASEAN. On average and during the period under review, high-skill and technology-intensive manufactures exported by the EU to ASEAN reached 49%, medium-skill and technology-intensive manufactures accounted for 37%, low-skill and technology-intensive manufactures reached 8%, while labour-intensive and resource-intensive manufactures accounted for 6%. As shown in Table 2, the ASEAN countries display great heterogeneity in the technological specialisation pattern of manufactured exports, countries such as Singapore, Malaysia, the Philippines, and Thailand show a sizeable percentage of high-skill and technology-intensive manufactures exported to the EU. Other countries such as Cambodia, Laos, or Myanmar do not export this type of manufactures to the EU, which is consequently linked to an early stage of development. In the EU, Malta, Ireland, Cyprus, and France stand out due to high technological content of goods exported. These results broaden the conclusions of the study carried out by Andreosso-O'Callaghan and Nicolas (2008), showing great heterogeneity in the EU-ASEAN trade regarding technological intensity of manufactures traded.

It seems likely that two of the main reasons for Malta having significant levels of exports with high technological content lie in the technological transfer to Maltese companies from foreign direct investment (FDI), and due to an information and communication technology (ICT) environment which serves as a great supporting tool for companies (European Commission 2010). In the case of Cyprus, it is important to consider its strategic position as important hub for transshipment companies worldwide, which provides a substantial role as re-export centre (Statistical Service of Cyprus 2018). The existence and encouragement of high-tech clusters is a crucial determinant for the great percentage of high-skill and technology-intensive manufactures exported by Ireland (Barry 2006). Successful development of high-tech clusters in Ireland had its roots in multiple factors such as the role played by FDI (O'Connor et al. 2017), the Irish universities supplying graduates with high skills, the implementation of policies supporting manufacturing companies as is the case of a favourable corporate tax, or the leading role played by the Irish financial institutions (Roche et al. 2008). The main French manufactures with high technological intensity exported to the ASEAN are 'aircraft and associated equipment', a sector with relevant R&D and technology expertise, with a strong presence in France.

Table 2 Percentage share of manufacturing exports by degree of technological intensity in the total EU-ASEAN manufacturing trade

Country	Labour-intensive and resource-intensive			Low-skill and technology-intensive			Medium-skill and technology-intensive			High-skill and technology-intensive		
	2004	2016	Aver.	2004	2016	Aver.	2004	2016	Aver.	2004	2016	Aver.
Austria	10.55	9.46	**8.56**	8.57	8.95	**9.70**	34.65	33.07	**39.13**	46.21	48.50	**42.58**
Belgium	9.05	4.34	**5.56**	12.64	7.15	**12.08**	25.83	25.06	**25.10**	52.46	63.42	**57.23**
Bulgaria	15.25	12.55	**8.02**	33.33	0.79	**7.96**	15.58	14.66	**19.29**	35.83	71.98	**64.71**
Croatia	17.33	5.99	**7.72**	21.77	7.55	**20.39**	59.73	68.95	**64.11**	20.74	17.49	**7.76**
Cyprus	1.34	0.50	**0.39**	0.27	0.70	**0.69**	8.51	23.32	**14.10**	89.97	75.46	**84.80**
Czechia	9.30	7.08	**7.72**	5.49	4.37	**5.65**	30.15	37.79	**40.12**	55.04	50.75	**46.49**
Denmark	6.80	3.96	**5.08**	5.71	16.65	**19.25**	48.73	38.68	**42.99**	38.74	40.69	**32.66**
Estonia	56.35	4.71	**20.45**	4.03	5.81	**8.59**	4.87	39.43	**29.50**	34.73	50.03	**41.44**
Finland	21.89	22.81	**19.92**	7.89	5.46	**8.28**	34.03	50.40	**47.04**	36.18	21.30	**24.74**
France	6.38	9.45	**5.87**	5.63	2.70	**4.17**	24.85	12.68	**17.03**	63.12	75.15	**72.92**
Germany	4.29	3.88	**4.02**	5.50	5.64	**6.04**	41.16	48.99	**44.90**	49.04	41.47	**45.02**
Greece	10.95	18.85	**20.46**	49.83	7.11	**18.30**	13.71	34.09	**24.16**	25.50	39.93	**37.06**
Hungary	2.02	3.36	**1.29**	1.49	2.01	**1.44**	47.11	54.24	**37.89**	49.33	40.37	**59.36**
Ireland	0.49	0.64	**0.45**	1.12	1.66	**1.20**	4.05	6.36	**7.00**	94.32	91.32	**91.33**
Italy	11.59	17.81	**13.72**	6.70	5.73	**10.52**	41.28	48.39	**47.85**	40.41	28.05	**27.88**
Latvia	12.46	3.48	**22.19**	0.02	4.87	**5.87**	28.23	20.36	**25.21**	59.27	71.27	**46.72**
Lithuania	54.14	12.79	**31.30**	32.37	3.74	**11.94**	3.84	27.45	**22.72**	9.63	56.00	**34.02**
Luxembourg	15.42	27.41	**14.63**	36.35	29.31	**38.61**	28.23	35.32	**26.49**	19.98	14.65	**20.25**
Malta	0.06	0.01	**0.07**	1.46	1.30	**1.58**	0.69	3.56	**2.00**	97.76	94.98	**96.33**
Netherlands	4.47	2.40	**3.75**	5.04	7.77	**8.70**	26.47	40.53	**39.10**	64.00	49.28	**48.43**
Poland	13.06	4.47	**6.46**	27.00	39.87	**39.24**	28.67	26.91	**28.25**	31.25	28.47	**26.04**
Portugal	3.50	26.05	**14.76**	0.35	6.04	**3.22**	12.89	36.83	**21.25**	83.24	31.05	**60.75**

Table 2 (continued)

Country	Labour-intensive and resource-intensive			Low-skill and technology-intensive			Medium-skill and technology-intensive			High-skill and technology-intensive		
	2004	2016	Aver.	2004	2016	Aver.	2004	2016	Aver.	2004	2016	Aver.
Romania	7.17	7.25	**6.45**	64.81	14.30	**28.85**	20.93	55.90	**49.50**	7.07	22.53	**15.18**
Slovakia	8.38	11.53	**8.54**	5.90	2.89	**3.54**	28.11	57.06	**45.06**	57.58	28.54	**42.85**
Slovenia	13.76	17.85	**9.91**	10.61	8.07	**10.02**	39.82	42.48	**46.40**	35.79	31.57	**33.65**
Spain	13.60	16.12	**14.29**	18.39	12.04	**18.82**	26.33	30.56	**28.77**	41.94	41.26	**38.09**
Sweden	14.34	13.50	**12.58**	6.66	7.93	**9.82**	39.59	54.59	**45.36**	39.39	23.96	**32.23**
UK	5.35	4.09	**4.76**	8.44	4.02	**8.56**	38.32	58.05	**50.16**	47.86	33.82	**36.50**
EU28	**6.70**	**7.29**	**6.27**	**6.69**	**6.00**	**8.00**	**33.93**	**39.49**	**37.31**	**52.66**	**47.19**	**48.40**
Brunei Darussalam	4.42	1.57	**7.27**	6.38	1.13	**2.62**	12.62	54.97	**27.06**	76.56	42.32	**63.03**
Cambodia	99.32	92.90	**93.79**	0.53	6.46	**5.71**	0.06	0.32	**0.14**	0.22	0.31	**0.34**
Indonesia	60.55	52.72	**53.92**	4.63	4.40	**5.19**	10.09	15.97	**14.11**	24.70	26.89	**26.77**
Laos	97.42	98.32	**94.72**	1.64	0.13	**0.74**	0.13	1.01	**0.95**	0.79	0.64	**3.56**
Malaysia	12.02	11.84	**11.69**	3.02	3.34	**4.07**	16.50	21.57	**19.31**	68.45	63.22	**64.84**
Myanmar	99.18	95.12	**97.96**	0.73	0.18	**0.68**	0.02	0.18	**0.85**	0.05	2.81	**0.49**
Philippines	6.31	5.51	**5.14**	1.54	8.16	**4.97**	10.16	13.43	**17.18**	81.95	72.89	**72.69**
Singapore	3.89	1.68	**1.72**	2.11	4.29	**3.79**	6.77	16.88	**12.59**	87.21	77.13	**81.88**
Thailand	20.56	11.89	**15.39**	4.28	6.02	**5.79**	33.06	34.94	**31.93**	42.08	47.14	**46.87**
Vietnam	82.85	38.12	**60.24**	9.77	4.76	**6.82**	3.60	6.41	**6.14**	3.76	50.70	**26.79**
ASEAN	**20.31**	**22.52**	**20.36**	**3.28**	**4.82**	**4.69**	**13.66**	**16.95**	**16.48**	**62.73**	**55.69**	**58.45**

Aver.: Average 2004–2016

Note: Author's calculation using UNCTADstat data

Giant aircraft manufacturers such as Airbus, Dassault, and Eurocopter, or engine and equipment manufacturing firms such as Safran, Thales, and Zodiac Aerospace, are based in France.

Table 2 also shows the technological breakdown development of manufacturing exports traded between the two trading blocs, over the study period. In general, it can be said that in the reported time series, there are no significant changes about the average figures.

In conclusion, the analysis carried out in this section shows that there is a large disparity regarding technological intensity of countries' exports in bilateral EU-ASEAN trade. We have identified some of the potential underlying causes of the satisfactory performance of those countries with a greater proportion of exports with a high technological content. To identify certain similarities in export patterns between the two blocs in the high technology intensity segment, it becomes relevant to determine whether the prevailing trade in bilateral trade EU-ASEAN shows characteristics of intra-industrial trade, analysis carried out in the following section.

EU-ASEAN intra-industry trade of high-skill and technology-intensive manufactures

From the economic policy perspective, ascertain the prevailing type of trade is crucial when designing and implementing trade policies that support deepen trade integration between countries and trading blocs. Moreover, policymakers must consider the predominant type of trade between trading partners to face challenges arising along the internationalisation processes, such as developing high performing financing schemes. Moreover, it is crucial to determine with certain degree of precision the role that GVCs play in bilateral trade, with the end goal of establishing an efficient and flexible inventory management (OECD 2018). Additionally, several other aspects such as improvements in connectivity, standardisation agreements, export finance schemes, human capital formation, rules of origin, and customs clearance processes should not cause significant delays and costs to companies in logistic and inventory management, since a product can cross borders several times to undergo different transformations along the value chain, which need infrastructure and complementary professional services to operate properly (Miroudot et al. 2013).

In this paper, we use a widely accepted index proposed by Grubel and Lloyd (GL) (1971) to measure the relevance of intra-industry trade EU-ASEAN, defined as:

$$GL_i^{jk} = 1 - \frac{\left|X_i^{jk} - M_i^{jk}\right|}{X_i^{jk} + M_i^{jk}}$$

where X_i^{jk} is the value of country j's exports to country k of product i, and M_i^{jk} is the value of country j's imports from country k of product i.

One of the main shortcomings of using the GL index is that level of disaggregation in the classification of manufacturing goods must be high to assure accurate

conclusions. Therefore, we implement in our study a high level of disaggregation to prevent the index from capturing the 'vertical trade' phenomenon[4], which has little to do with convergence and monopolistic competition, and more closely resembles a Hecksher–Ohlin type trade[5].

Using the data source of UN Comtrade database for the years 2004–2016, we will go deeper into the study of those high-skill and technology-intensive manufactures with a significant weight in bilateral manufacturing trade between the two blocs, to determine manufactures that face an increased likelihood of intra-industry trade presence. Therefore, Table 3 shows the high-skill and technology-intensive manufactures traded by member states in trade between EU-ASEAN, with a high likelihood of intra-industry trade, measured by the GL index, on average and during the study period.

(776) 'Cathode valves and tubes' (3-digit SITC-rev.3)

(776) 'Cathode valves and tubes' are the main high-skill and technology-intensive manufactures traded between the EU and ASEAN. Germany is the main EU's exporter of these manufactures to ASEAN with 40% of the EU total, followed by France with 17%, and Ireland with 10%. Singapore accounted for 45% of the total ASEAN's exports to the EU, followed by Malaysia with 26% and the Philippines with 20%. (7764) 'Electronic integrated circuits and micro-assemblies' accounts for almost 90% of EU-ASEAN trade of manufactures under the heading (776) 'cathode valves and tubes'. Intra-industry trade under the subheading (7764) 'Electronic integrated circuits and micro-assemblies' is primarily concentrated on trade in (77649) 'Other electronic integrated circuits and micro-assemblies', focused on trade between Germany and Malaysia with a GL index of 0.79, between France and Singapore with an index of 0.69, Germany and the Philippines with an index of 0.65, France and Malaysia with an index of 0.68, and between France and the Philippines with an index of 0.88.

(874) 'Measuring, analysing, and controlling apparatus not elsewhere specified (n.e.s.)' (3-digit SITC-rev.3)

EU-ASEAN trade under this heading is mainly concentrated in trade flows from Germany, the UK, Singapore, and Malaysia. Half of the bilateral trade Germany-Singapore exhibits characteristics of intra-industry trade, mainly focused on (87443) 'spectrometers, spectrophotometers and spectrographs', and under the subheading (87445) 'other instruments and apparatus using optical radiations', both with a GL index of 0.75. The intra-industry trade between Germany and Malaysia is concentrated in: (87449) 'microtomes' with a GL index of 0.91, (87425) 'measuring or

[4] In vertical trade, products that exhibit heterogeneity in the quality, cost and technology used are commercialised (exported and imported), unlike the horizontal trade in which products with homogeneous quality, cost and technology used are traded (Dautovic *et al*. 2014).

[5] The analysis in this section is based on SITC-rev.3 at 3, 4 and 5-digit level of disaggregation.

Table 3 High-skill and technology-intensive manufactures in EU-ASEAN trade with high levels of intra-industry trade (Average 2004–2016)

Manufactures	Countries involved	GL index
(77649) Other electronic integrated circuits and micro-assemblies	Germany-Malaysia	0.79
	France-Singapore	0.69
	Germany-The Philippines	0.88
	France-Malaysia	0.88
(87443) Spectrometers, spectrophotometers and spectrographs	Germany-Singapore	0.75
	Germany-Malaysia	0.96
(87449) Microtomes	Germany-Malaysia	0.91
(87425) Measuring or checking instruments	Germany-Malaysia	0.90
(87445) Other instruments and apparatus using optical radiations	Germany-Singapore	0.75
(8774) Instruments and apparatus for physical or chemical analysis, measuring or checking viscosity	UK-Singapore	0.79
(8747) Oscilloscopes, spectrum analysers and other instruments and apparatus for measuring or checking electrical quantities	UK-Malaysia	0.78
(7643) Transmission apparatus for radiotelephony, radiotelegraphy, radiobroadcasting or television	Sweden-Malaysia	0.98
(76493) Parts and accessories of telecommunications and sound-recording and reproducing apparatus	Sweden-Singapore	0.75
	Germany-Singapore	0.80
(7648) Telecommunications equipment	Germany-Malaysia	0.75

Note: Author's calculation using UN Comtrade database

checking instruments' with a GL index of 0.90, and (87443) 'spectrometers, spectrophotometers and spectrographs using optical radiations' with a GL index of 0.96. UK-Singapore trade flows that exhibit characteristics of intra-industry trade are concentrated in (8774) 'instruments and apparatus for physical or chemical analysis, measuring or checking viscosity, porosity, expansion, surface tension or the like, for measuring or checking quantities of heat, sound or light, and microtomes', with a GL index of 0.79, although it hardly accounts for 15% of bilateral trade under the heading (87425) 'measuring, analysing and controlling apparatus n.e.s.'. Bilateral trade UK-Malaysia shows characteristics of intra-industry trade under the subheading (8747) 'oscilloscopes, spectrum analysers and other instruments and apparatus for measuring or checking electrical quantities', with a GL index of 0.78, reaching 40% of bilateral trade under (87425) 'measuring, analysing, and controlling devices'.

In general, looking at EU-ASEAN trade flows of high-skill and technology-intensive manufactures, we can conclude that there is a moderate presence of intra-industry trade, focused on selected manufactures, in many cases without a significant value in trade flows, and concentrated in few countries. Our findings denote a high trade complementary between the two trading blocs, which are in line with the results of previously conducted research by Andreosso-O'Callaghan and Nicolas (2007) and Vahalik (2014). Thus, in the face of deepening EU-ASEAN trade, this complementarity could help to achieve greater trade gains from greater integration. Regarding the factors on the emerge of intra-industry trade over the last decades, many trade models have tried to outline those determinants, such as the role of inward FDI flows (Yong et al. 2019), cross-countries technical differences (Kikuchi et al.,2005), distance between trade partners (Balassa and Bauwens 1987), and similarity in factor endowments (Sawyer et al. 2010). The positive relationship between inward FDI flows and intra-industry, and the negative correlation between distance and intra-industry trade are not clear in the ASEAN case (Sawyer et al., 2010). However, it is important to point out that FDI inflows in Southeast Asia have been of overriding importance for the relocation of multinational corporations (Rasiah, 2003, 2009), particularly in some countries such as Malaysia. Since the 1970s, Malaysia has been attracting and retaining FDI into the electronic industry through establishing tax-free export processing zones, source of an export-oriented industrialisation, becoming the main driver of manufacturing growth, and a crucial driver of labour productivity.

A bilateral trade structure that exhibits a high likelihood of inter-industry trade presence as the previous outlined analysis, the study of revealed comparative advantages gain relevance.

Comparative advantages of high-skill and technology-intensive manufactures traded EU-ASEAN

According to the Economic Integration Theory, FTA can provide additional benefits to participating countries, such as intensify economies of scale (Corden 1972), provide greater market competition (Harrison et al. 1996), improve consumer surplus (Viner 1950; Behrens et al.,2007), or specialisation in those goods in which comparative advantages are found (Forslid and Wooton 2003), among others. Through

the analysis of the revealed comparative advantages (VCR) of the main manufactures exported between the EU and ASEAN, we analyse to what extent VCR are translated into higher market shares. If this is not the case, it is likely that trade barriers play a certain role in determining trade patterns, and we can envisage how the dismantling of these trade barriers could provide greater efficiency in the allocation of resources, taking place what might be termed as a positive deviation of trade within the two trading blocs, exporting more of those manufactures in which VCR are relevant.

To complement the analysis of intra-industrial trade carried out in the previous section, we use a generally accepted VCR index proposed by Lafay (Ll) (1992), defined as:

$$Ll_i^j = \frac{1000}{Y_j} \frac{2\left(X_i^j M_i - X_i M_i^j\right)}{X_i + M_i}$$

where X_i^j is the value of country j's exports of product i, $X_i = \sum_j X_i^j$ is the value of world exports of product i, M_i^j is the value of country j's imports of product i, $M_i = \sum_j M_i^j$ is the value of world imports of product i, Y_i is the country j's GDP. A value of the revealed comparative advantage greater than the unit implies that the country has a comparative advantage revealed in the product. The distribution of the Ll index of a country has a non-variant mean over time, that is to say, $\sum Ll_i^j = \frac{1000}{Y_i} \frac{2\left(X_i^j M_i - X_i M_i^j\right)}{X_i + M_i} = 0$, which means a greater reliability of this index when comparing over time between manufactures within the same country. The reason for using the Ll index lies in the ability of this index to capture re-exports[6] and intra-industrial trade flows, by using the export and import variables, controlling likely macroeconomic distortions due to business cycle by incorporating the GDP variable (Alessandrini et al. 2007).

Table 4 shows the results of the high-skill and technology-intensive manufactures with the highest values of Ll index exported by the EU and ASEAN. From in-depth analysis, we observe that in many manufactures, the EU countries exhibit Ll index values greater than their competitors, but with lower market shares in the ASEAN market. When considering ten manufactures exported with high technological intensity in which the EU exhibit higher values of Ll index, we observe that in eight of these manufactures, the EU has comparative advantages over its competitors, although lower market shares. For instance, we note that Germany is the fourth main exporter to ASEAN of (583) 'plastic monofilaments', with a market share of 6%, and a Ll index value of 4.23, much higher than China index of 0.8, whose market

[6] The re-export phenomenon gains importance in countries that serve as important logistical and distribution hubs, such as the Netherlands and Germany in the EU, and Singapore in ASEAN.

Table 4 The highest Lafay index values in high-skill and technology-intensive manufactures in EU-ASEAN trade

	2004	2016	Average
Manufactures exported by the EU			
(542) Medicaments (incl. veterinary).	1.168	1.853	**1.502**
(792) Aircraft & associated equipment; spacecraft, etc.	1.347	1.372	**1.251**
(583) Monofilaments, of plastics, cross-section >1 mm.	0.984	1.234	**1.126**
(874) Measuring, analysing & controlling apparatus, n.e.s.	1.126	1.187	**1.068**
(553) Perfumery, cosmetics, or toilet prepar.	0.113	0.129	**0.129**
(515) Organo-inorganic, heterocycl. Compounds.	0.113	0.065	**0.100**
(598) Miscellaneous chemical products.	0.070	0.097	**0.083**
(533) Pigments, paints, varnishes, etc.	0.063	0.061	**0.072**
(575) Other plastics, in primary forms.	0.086	0.040	**0.073**
Manufactures exported by the ASEAN			
(751) Office machines.	1.052	1.043	**1.043**
(579) Waste, parings, and scrap, of plastics.	1.027	1.026	**1.035**
(883) Cinematograph filmes, exposed & developed.	1.019	1.038	**1.037**
(532) Dyeing & tanning extracts, synth. tanning materials.	1.014	1.034	**1.020**
(583) Monofilaments, of plastics, cross-section >1mm.	0.013	0.025	**0.029**
(593) Explosives and pyrotechnic products.	0.022	0.023	**0.029**
(525) Radio-actives and associated materials.	0.005	0.021	**0.017**
(762) Radio-broadcast receivers, whether or not combined.	0.017	0.015	**0.012**
(891) Arms & ammunition.	0.011	0.017	**0.016**

Aver.: Average 2004–2016

Note: Author's calculation using UNCTADstat data

share is 34%, due to a large extent to the ASEAN-China FTA[7]. In the heading (553) 'perfumery, cosmetic or toilet preparations', Ireland is the fourth main exporter to ASEAN with a Ll index value of 40, but the USA is the main exporter with a Ll index value of 1.02.

In the case of ASEAN exports to the EU, as we have pointed out concerning the EU exports to ASEAN, data reveals that high Ll index values are not correlated with larger market shares. Thus, Malaysia is the fifth biggest exporter to the EU of (881) 'photographic equipment', and although it has a greater comparative advantage than most of its competitors, Malaysia exports to the EU less than China, USA, or Switzerland. In the heading of (776) 'thermionic valves and tubes', Malaysia is the third largest exporter to the EU, with a Ll index value of 4.6, but China is the main exporter with a Ll index value of 1.5, the USA is the second exporter, with a Ll index value of 1.05. In the 'office machines' heading, Vietnam is the fourth largest exporter to the EU, with a Ll index value of 5.74, yet China is the main exporter

[7] We note that plastic monofilaments trade between ASEAN and China has substantially increased since the ASEAN-China FTA agreement was signed in 2002.

with a Ll index value of 3.37, and Japan is the second largest exporter, with a Ll index of 0.90. This phenomenon occurs in almost all categories with high technological intensity in which ASEAN Member States offers comparative advantages.

The underlying potential causes of the evidence found in the previous analysis of comparative advantages using the Ll index are multiple. We can mention the strategic trade policy actions to support the internationalisation of companies abroad (Krugman, 1986; Spencer and Brander, 1983; Brander, 1985), the role of distance in international manufacturing trade, the role of tariff and non-tariff barriers, or the eventual use of comparative advantages derived from FTAs between business partners, among others. One of the overall findings coming from the revealed comparative advantages analysis performed on the main manufactures in EU-ASEAN trade is that manufactures with greater revealed comparative advantages exported by the EU to ASEAN, differ from manufactures with greater revealed comparative advantages exported by ASEAN to the EU. This bears out the high complementarity in regional trade patterns.

Conclusions

This article analyses the trade flows of manufactures EU-ASEAN concerning their technological intensity, during the period 2004–2016, placing emphasis on manufactures with a higher technological content. Based on the results achieved, and due to the significant role, that ASEAN and the EU play in the international trade of manufactured goods, it is observed that the bilateral trade in manufactures between these two trading blocs has potential for further improvement, both in absolute and relative terms, since only 1.7% of manufactured goods exported by the EU reach ASEAN, while this percentage is 14% for ASEAN manufactured goods exported to the EU. These findings entail significant challenges and opportunities for those companies facing internationalisation processes, and for governments and institutions at the time of implementing policies to foster those internationalisation processes. In general terms, the analysis of Grubel–Lloyd index on EU-ASEAN trade confirm that intra-industrial trade is moderate, mainly focused on few manufactures, accounting for a low value of total trade flows between the two blocs and concentrated in a few countries.

A trade with a low presence of intra-industrial trade pinpoints the policy measures to support the internationalisation of companies, focusing the analysis on policies that help countries to better exploit the comparative advantages of both trading blocs. An example of such economic policy measures are those involving the support for the internationalisation of small and medium sized enterprises, which should pay particular attention to maximise the comparative advantages, highlighting those weaknesses in the internationalisation processes regarding this type of companies, such as information problems, difficulties in access to finance, reluctance of small businesses to grant credit to foreign clients, and tackling cultural and language barriers (Zoltan et al. 1997; Freund et al. 2016). Hence, when intra-industrial trade plays a residual role, the study of comparative advantages becomes more relevant, since the role of relative factor endowments among business partners

may be a major factor in determining and enhancing international trade flows. Lafay index values indicate that the EU has greater comparative advantages as the technological content of manufactures increases, it is also observed that of the ten manufactures with high technological intensity exported to ASEAN in which the EU has greater index values of comparative advantages, in eight of these manufactures, the EU accounts for higher values of the Lafay index than its competitors, although the EU market shares are significantly lower than those competitors. In the case of ASEAN manufacturing exports to the EU, the manufactures in which ASEAN has greater comparative advantages are framed in the medium-intensity technology segments, and as in the case of EU exports to ASEAN, a more in-depth analysis of data reveals that the presence of these comparative advantages are not correlated with a greater market share. The values obtained with the Lafay index indicate that the EU and ASEAN are natural partners regarding the patterns of these revealed advantages; therefore, a deepening in trade integration between this trading blocs could allow to exploit those comparative advantages and deepen complementarity in trade patterns through greater specialisation.

Consequently, it would be necessary that, in the event of a possible FTA the EU and ASEAN, efforts on promoting bilateral trade in those manufactures in which countries have comparative advantages should focus in removing tariff and non-tariff barriers. Alleviating the barriers to trade, together with measures to strengthen intellectual property rights and safeguards to ensure fair competition, will provide a business-friendly environment for European companies involved in global value chains based in ASEAN countries.

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