



Measuring Dependency of International Trade Aerospace Sector

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Article Information Abstract

History of Article

Received January 2022

Accepted March 2022

Published May 2022

Keywords:

aerospace, international trade, dependence, Indonesia

This research aims to quantify the specialization stage of Indonesia, followed by the dependencies of Indonesia's imports on the aerospace sector. Since, there are still few studies about the aerospace sector, especially from an economic perspective. This research conducted to fulfill the gap studies on international trade aerospace sector phenomenon. The sample used in this research is 9 countries between 2001 – 2018. Methods will be conducted in two steps. First, by using Trade Specialization Index (TSI), we try to identify the specialization stage of each country in the aerospace sector. Second, we used Import Dependency Ratio (IDR) to identify the level of Indonesia's dependency in the aerospace sector on other countries. We found that Indonesia still reaching the introduction stage of specialization. Adding relevancy to the result, Indonesia is also considered as highly-dependent on other countries in terms of the aerospace sector. We therefore suggest that Indonesia needs to raise traction in the aerospace sector by increasing its budget and conducting technology transfers, so Indonesia's competitiveness will raised.

INTRODUCTION

The rapid development of technology has led us to expand more economic coverage, including the aerospace sector. This sector was once only utilized by the military, but now it has been commercialized (Weinzierl, 2018). For instance, commercialized aerospace products are the internet, television, and GPS (George, 2019). Enthusiasm toward the aerospace sector also could be portrayed by the increase of the aerospace budget by 37 percent from 2007 to 2012. Aerospace investment also increased by 9.2 times in 2005 – 2009, totaling 9.1 billion USD (Viens, 2019). Currently, United States took the first place in terms of aerospace investment

(Giannopapa, 2015). Meanwhile, Indonesia is still considered to have a very small aerospace budget, which is 0.005 - 0,007 percent of GDP (See Figure 1). The small amount of space budget also could be reflected by aerospace technological mastery and aerospace assets. Therefore, these constraints have caused Indonesia to not be able to become an “actor” in the aerospace sector but become a target market by other countries. “Actor” in this term refers to the country that handles the whole supply chain of space manufacturing (aircraft, rockets, and satellites), services from satellite operators (bandwidth, imagery, broadband, etc.), and consumer services (satellite navigation, television services, etc.) (Schrogl et al., 2015).

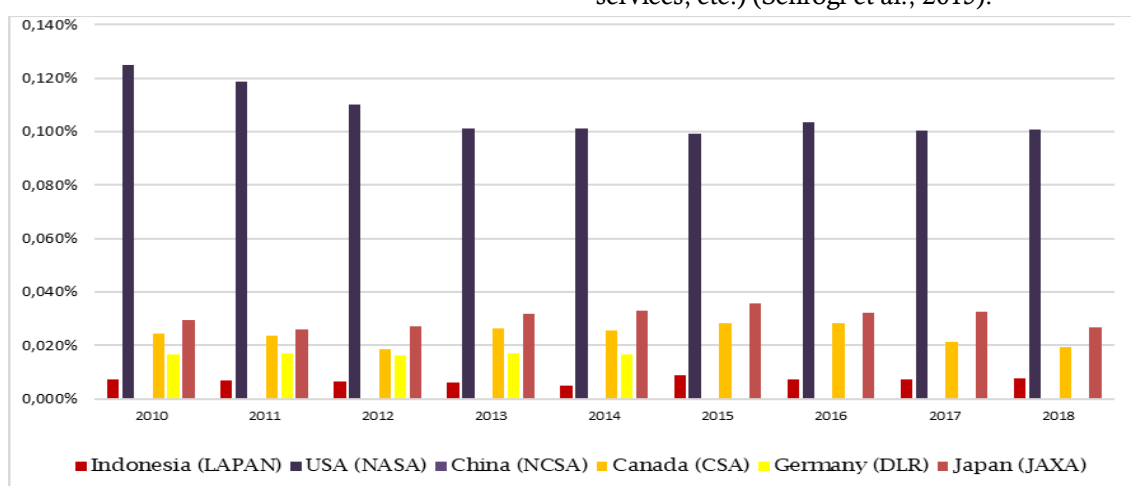


Figure 1. Percentage of Space Agency Budget to GDP

Source: (DLR, 2019; Government of Canada, 2019; JAXA, 2019; NASA, 2019)

Note: Indonesia's space budget data is available upon request; China space budget data is not available

Therefore, as a consequence of no comparative advantage (Salvatore, 2013; Skousen, 2019), Indonesia will be burdened with aerospace products import. This can't be prolonged because Indonesia needs to be less dependent on aerospace products. One idea is to conduct import substitution, thus being able to reach self-sufficiency. Being less dependent on imports could make countries more resilient to both external and internal shocks (Mogsawad, 2010). Also, financial straitjacket could be evaded (Rüdiger, 2019). Therefore, being less dependent on aerospace product must be a concern for the government. Moreover, aerospace sector development offers an immense amount of multiplier effects (Schrogl et al., 2015)

To achieve self-sufficiency, the government needs to increase its aerospace sector technology development (Rishwanda, 2002), but in fact, there is still a lack of research and development concern in Indonesia's aerospace sector (Suharman et al., 2018). This is in contrast with Indonesia Space Law (Undang-Undang Republik Indonesia Nomor 21 Tahun 2013 Tentang Keantariksaan), in which increasing competitiveness of the aerospace sector has become a mandate of Indonesia

There are still few studies about the aerospace sector, especially from an economic perspective. Some studies cover legal aspects (Nugraha & Paramita, 2019), input-output (Highfill & MacDonald, 2022), efficiency

(Monteiro et al., 2022), and market (Altıparmak & Xiao, 2021). To our knowledge, no study assesses international trade in the aerospace sector in Indonesia. Given the gaps above, we aim to quantify the specialization stage of Indonesia, followed by the dependencies of Indonesia's imports on the aerospace sector. Also, this research has the main contribution by giving scholars and policymakers a deeper understanding of the international trade of aerospace sector in Indonesia. In specific, this research expected to become a consideration in the policymaking.

Several limitations are worth mentioning. First, from 2019 onwards, the Indonesia space agency/LAPAN being is still in the transition period into the research and innovation agency/BRIN, thus no data supported. Second, there is a budget reallocation that makes LAPAN make no international tender due to the Covid-19 pandemic, which happens from 2019 onwards. We expect that during that period there's not much insight that could be taken, thus we limit our period to 2018. Third, the aerospace sector has dual-use functionality, which some of them are confidential military data. Therefore, the data might not fully reflect the truth

As guidance, this research will be divided into four sections. This section, or so-called first section, will present the foundational foundation of this research concept. The second section will explain the data and methods that will be used. The third section will result and discussion. Lastly, the fourth section consists of the conclusion, limitation, future research guidance, and policy implication followed by its recommendation.

RESEARCH METHODS

The research used a quantitative descriptive approach through two steps. First, we used Trade Specialization Index (TSI). Some studies also used TSI to identify countries tendency of export or import towards related product (Benedictis et al., 2009; Riniwati et al.,

2020; Saleh & Widodo, 2010). Second, Import Dependency Ratio (IDR) used to quantify import dependency level of respective countries. Some studies still use IDR as one of their measures to examine international trade topics (López & Thomas, 4 C.E.; Tian et al., 2011; Yang & Jiansuo, 2007). Below is the equation of Trade Specialization Index (TSI):

$$TSI = \frac{(X_{it}-M_{it})}{(X_{it}+M_{it})} \dots\dots\dots(1)$$

where, X_{it} is Export of commodity i in years t ; and M_{it} is Import of commodity i in years t . Meanwhile, Import Dependency Ratio (IDR) can be decomposed as follows:

$$IDR = M_{it} \times \frac{100}{(Cap_{it}+ M_{it} - X_{it})} \dots\dots\dots(2)$$

where, M_{it} is Import of commodity i in years t ; Cap_{it} is Production of commodity i in years t ; and X_{it} is Export of commodity i in years.

Data of export, import, and production were taken from Comtrade (2020). We used "Product: 88 Aircraft, spacecraft, and parts thereof" as the commodity nomenclature. Its nomenclature consisting flight products, spacecraft, and the like. Year of 2001 – 2018 used as the time span. Countries that used in this research are Indonesia, China, Germany, USA, Canada, and Japan. The rationale of country selection is based on their bilateral relationship with Indonesia, thus they are expected to have a large impact.

RESULTS AND DISCUSSION

Before we jump into the main result, we want to give a refreshment regarding trade balance. Indonesia trade balance is always deficit in the aerospace sector (See Figure 2). Spike in 2004–2012 was caused by immense development of unmanned aerial vehicle (UAV) by PT. Dirgantara Indonesia (PT. DI). However, it still not sufficient to decide that Indonesia has no specialty and high import dependency. Therefore, we move to our main results.

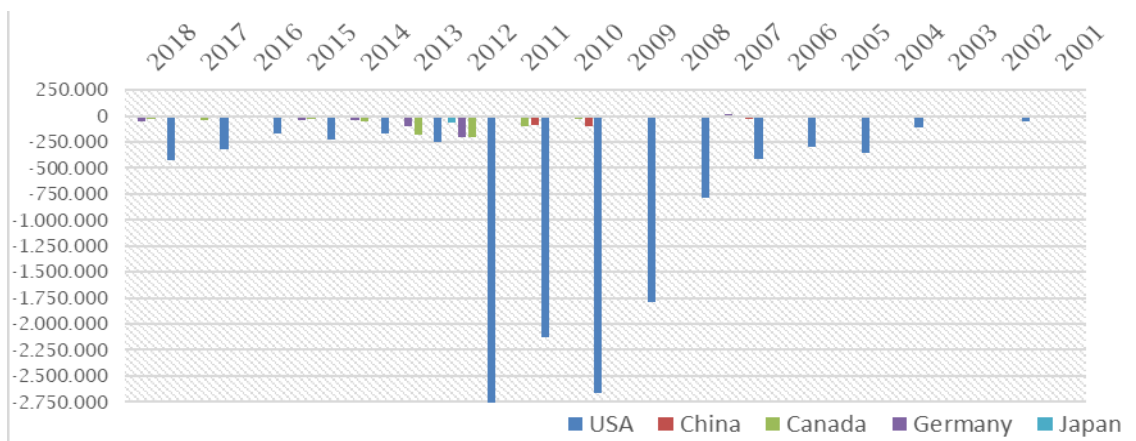


Figure 2. Trade Balance Indonesia of Aerospace Sector (Product 88: Aircraft, Spacecraft, and part thereof) in USD Thousand.

Source: Comtrade, 2020 (Processed)

Through the TSI, we got a result that shows a trend of the country's specialization that shown in Figure 3. According to the TSI graph, it can be concluded that Indonesia still does not have a specialization in the aerospace sector. This can be seen from the TSI which tends to band -1.0 to -0.5 against the United States, China, Canada, Germany, and Japan which means the sector is still in the introduction phase. Adapted from Vernon, (1966), we used 5 stages of production cycle to determine which stage of each respective TSI score.

First, introduction stage (-1.00 to - 0.50). This stage shows that the developed country exports goods that are not yet available in the country, and this country imports the goods.

Second, import substitution Stage (- 0.51 to 0.00). The country is starting to make an import substitution, but its products still have low

competitiveness and the level of production has not yet reached the economic of scale. At this stage, domestic production is lower than domestic demand.

Third, growth stage (0.01 to 0.80). The country has mass production and started to increase its exports. At this stage, domestic production is greater than domestic demand.

Fourth, maturity stage (0.81 to 1.00). The country has reached the standardization of its product related to the technology it contains and the country has become a net exporter.

The last steps is diminishing stage (<1.00). Developed countries that were previously superior had innovation and this country was unable to compete in the market, so the country returned to import related products until domestic demand were lower than domestic products

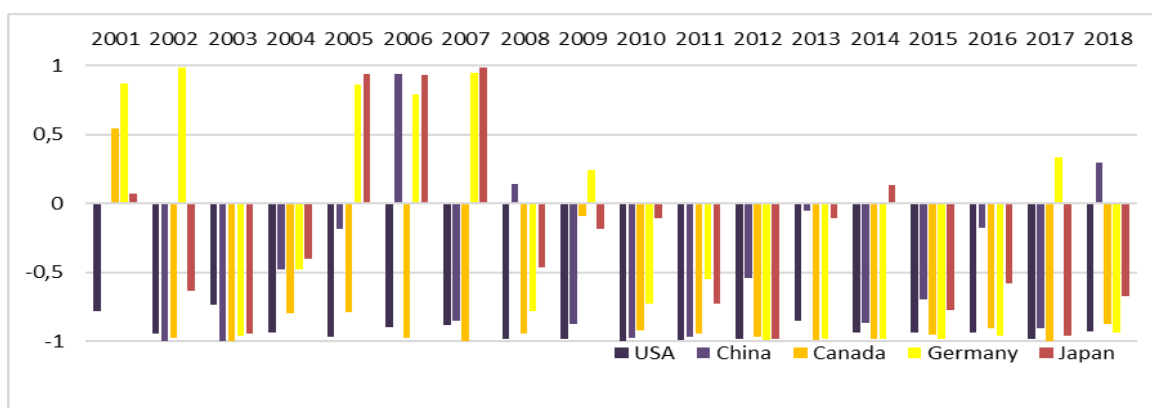


Figure 3. Graph of Indonesia Trade Specialization Index (TSI)

Source: Comtrade, 2020 (Processed)

Adding relevancy to the TSI, introduction stage also associated with the learning curve which implies Indonesia still in research and development phase, thus still not reaching optimal performance yet. It also partially answers the questions of why Indonesia still has deficit trade balance in aerospace sector.

In order to support the result above, we try to identify from supply chain side. It can be seen that there lie some gaps in aerospace supply chain in Indonesia (See Table 1). In tier 2 and tier 1, there are 5 out of 7 subsectors that missing in Indonesia. In downstream, there are 2 out of 5 subsectors that missing again in Indonesia. Those missing subsectors disrupt Indonesia supply chain and unable to fulfill the production, thus Indonesia forced to import.

Table 1. Importing Companies of Aerospace Product in Indonesia

Supply chain	Total companies
Tier 4 and 3:	
Research and development	7
Material and component for both space and ground system	3
Engineering system	3
Tier 2 and 1:	
Electronic equipment and software for space and ground system	n/a
Spacecraft/satellite platform structure and data handling subsystem	n/a
Guide, navigation and control subsystem, and actuators	n/a
Communications subsystem	1
Propulsion subsystem	1
Other satellite payloads specific subsystem	1
Prime:	
Complete satellite/orbital system	3

Supply chain	Total companies
Launch vehicle (and launch service provision in some cases)	2
Control centers and ground stations	3
Operator:	
Launch service provision	1
Satellite operations, including lease or sale of satellite capacity	6
Provision of control center services to third parties	5
Downstream:	
Chipset manufacturers	n/a
Satnav and telecom equipment and connectivity device vendors	n/a
VSAT network providers	5
Direct-to-home providers	8
Location-based signal service providers	5

Source: (Comtrade, 2020; Schrogl et al., 2015), (Processed)

In the second steps, we will discuss the result of IDR. We can see the dependencies of respective countries on Figure 4. Similar to the previous result, this IDR approach also shows that Indonesia's dependency on imports of the aerospace sector is still high, especially towards United States. Being highly import dependent bring some consequences.

Indonesia will have more exposure towards both internal and external shocks. Some countries could restrict some of their product in the certain times, moreover, aerospace product is considered as a sensitive product. This is because aerospace product has dual-use function, which is for military and commercial. Aside from political aspect, Indonesia will also be exposed to the currency ris

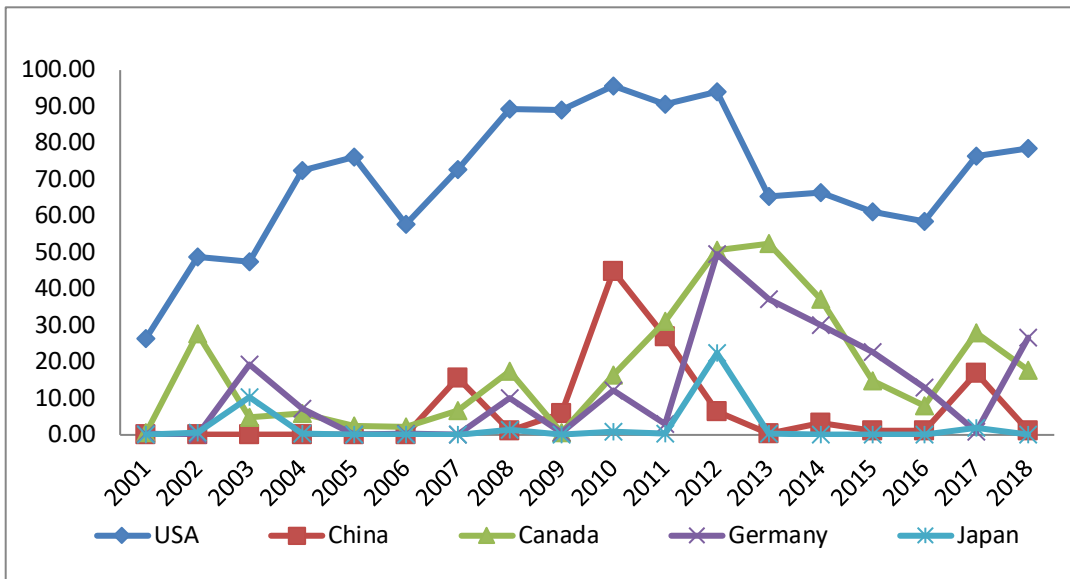


Figure 4. Indonesian Dependency Ratio on Aerospace Sector at 2001-2018
Source: Comtrade, 2020 (Processed).

Based on the results of TPI and IDR, Indonesia still on introduction stage toward aerospace specialization and also considered as high import dependent. However, Indonesian government already tried to put an effort towards specialization and self-sufficient of aerospace sector. With respect to Figure 5, it can be seen that export level of aerospace product has an uptrend, along with the increment of space

budget. This is implied that Indonesia getting the track towards aerospace specialty, even though it still a small change. Figure 6. shows that there is a downtrend in aerospace product import, again, along with the increment of space budget. This reduction means Indonesia try to reduce their dependency towards aerospace product import, even though it still considered as small movement

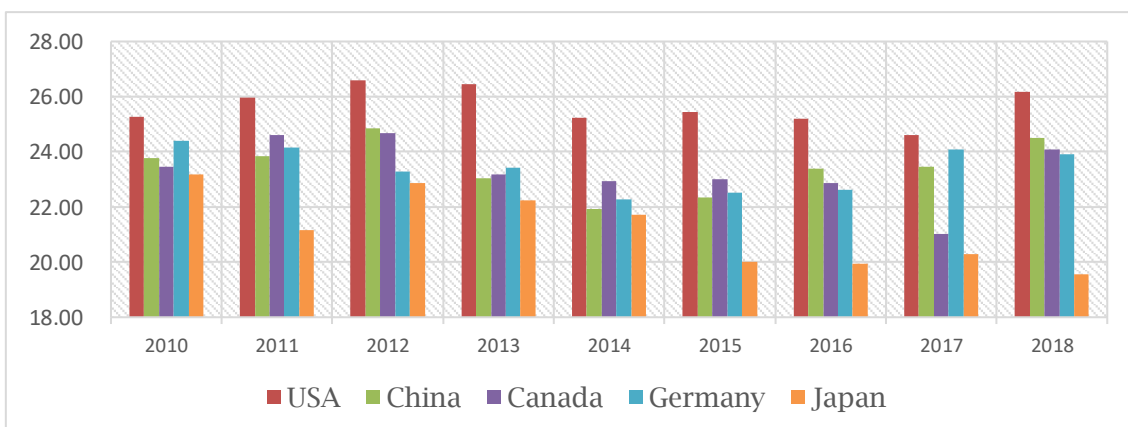


Figure 5. Trend of Indonesia Space Budget to Export Level in Aerospace Sector.
Source: Data Processed, 2022

Indonesia won't be a "rising space actor" if the government did not give enough concern to space budget. The increment in space budget would fill gap in the aerospace sector supply chain and support research and development,

thus bring solutions and innovations in the aerospace sector. However, there still no serious concern of Indonesian government towards aerospace still not exist (Perwitasari & Sutrisnanto, 2015).

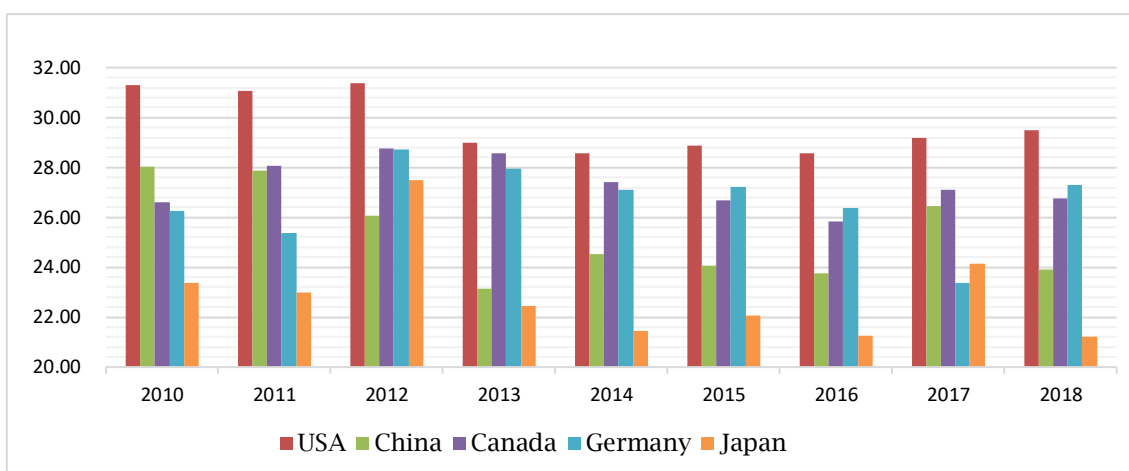


Figure 6. Trend of Indonesia Space Budget to Import Level in The Aerospace Sector
Source: Data Processed, 2022

There are some evidences to support why Indonesia must raise a concern towards research and development. For instance, China has an independent technology development strategy to support research and development of aerospace sector (Cheng, Harrison, 2002). As a result of these China aerospace technology is rapidly developed. Some lesson learned also could be taken from Korea. Concern of research and development in Korea makes them less import dependent and even become one of the leading technological countries (Hemmert, n.d.; Kim, 1997).

CONCLUSION

This research aims to quantify the specialization and import dependencies of Indonesia's aerospace sector. The result shows that Indonesia is still within the introduction stage, which implies Indonesia still does not yet have a specialty in aerospace products. Indonesia is also still has a high import dependency on other countries, especially the USA.

With respect to the limitations that we expressed in the first section, we want to give some future research references as guidance to extend this research. First, this topic could have an extended period after Covid-19 period, as the space agency will work normally. Also, LAPAN transition to BRIN should be settled down shortly, thus could provide supplementary data. Second, there might be micro data that could

separate between military and commercial use of the aerospace product in the future. Therefore, the next research could be done with only specific commercial aerospace products to avoid confidential data, thus the result will be more robust.

We have some suggestions that might be considered. First, the government needs to raise the concern of the aerospace budget. By raising the aerospace budget, we could improve our research and development, so Indonesia can fill the gaps in the missing supply chain. Second, the government needs to propose a strategy for import substitutions. This strategy could reduce import dependency and push domestic production, thus becoming more self-sufficient. Third, transfer knowledge of aerospace technology

The result of this research also has some policy implications. From the result, it can be seen that Indonesia needs to raise a concern about the aerospace budget. The government needs to allocate the other non-critical sectors' budgets to raise the aerospace budget, thus research and development could be more effective. For import substitutions, Indonesia needs to maintain diplomacy with other countries due to the reduction of imports from other countries. As a reminder, Indonesia has bilateral relationship towards those countries. Lastly, by conducting transfer knowledge, the

knowledge of aerospace needs to be implemented so supply chains gaps could be more resolved.

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