Norges miljø- og
biovitenskapelige
universitet

Master's Thesis 2019 30 ECTS
School of Economics and Business

Integration of the Vietnam's and China's salmon markets: the result of a Chinese sanction on Norwegian salmon?

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Acknowledgements

I would like to express my profound gratitude to my supervisor, Professor Roberto J. Garcia, for his support and patience. His helpful and detailed guidance has helped me in all the time of writing my thesis.

My sincere thanks also go to Ms. Kine Josefine Aurland-Bredesen for her valuable help with econometric models. I thank Mr. Xianwen Chen for his advice on data collection.

Last but not least, I would like to thank my parents, family in Vietnam and Norway and friends for their love and encouragement during my master study.

Abstract

China’s sanction, in the forms of stricter border controls against Norwegian salmon, was allegedly applied in response to the Nobel Peace Prize for 2010. Based on official trade data, the sanction seemed to succeed in restricting direct imports of Norwegian salmon into China. However, Norwegian salmon may have been re-exported or transshipped to China through a third country, for example, Vietnam. Because there are no reports on re-exports or legal transshipments from Vietnam to Norway, smuggling, a means of illegal transshipment, might have occurred.

In March 2011, Vietnam’s salmon import volume from Norway increased by more than three times. It has even surpassed China’s salmon import volume from Norway in many months since then. Vietnam’s strange behavior in salmon trade with Norway has occurred a few months after China’s first document that discriminatorily targets Norwegian salmon. By estimating the model of Vietnam’s import demand function, the study found that the sudden change in Vietnam’s salmon trade pattern with Norway cannot be explained by general trade theory.

This thesis is an attempt to establish the relationship between what has happened to imports of Norwegian salmon in Vietnam and China’s alleged sanction and the effect of the sanction on China’s salmon imports from Norway. The sanction acts as a structural break that divides the study period from July 1997 to December 2018 into two sub-periods. Lags of change in China’s import volume of Norwegian salmon have negatively significant effects on, or “Granger cause”, change in Vietnam’s after the sanction, but not before the sanction. This finding implies a statistical link between an increase (decrease) in Vietnam’s salmon imports from Norway and a decrease (increase) in China’s salmon imports from Norway due to the sanction, leading to price convergence in the long run. Therefore, the study gives statistical evidence that Vietnam’s and China’s salmon markets have become integrated as a result of China’s alleged sanction on Norwegian salmon. If so, market integration has happened in an unexpected manner because of an illegal sanction-bursting strategy, smuggling.

Keywords: *salmon, Norway, Vietnam, China, sanction, smuggling, import demand, structural break, Granger causality, price convergence, market integration.*

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1 Introduction

Trade policies can be adopted for economic and/or political purposes. The economic objectives of policy intervention might be to increase tax revenue, deal with balance of payment issues, protect infant industries, maintain a country's self-sufficiency and retaliate against foreign trade policies (Appleyard & Field, 2014). In some cases, a country uses trade barriers to signal its displeasure in international relations with other countries, and does not necessarily intend to achieve an economic advantage (Afesorgbor, 2019). In other words, it imposes tariff or non-tariff trade barriers as economic sanctions to express its attitude in political relationships. To behave in this manner effectively, the country should be a large importer/exporter such that any policy-induced changes in demand or supply for a product affects the world market or has serious long-term effects on the economy of the targeted foreign country.

China's economy has been growing at an average rate of about 10% since the 1990s (Trading Economics, 2018) to become the world's second largest economy in 2010 (Barboza, 2010). With that economic might has become a more assertive political posture. Starting in the 2000s, China resorted to economic sanctions as an international relations tool in the following cases: (1) when a country officially received the Dalai Lama; (2) a result of marine disputes or when support was offered to other countries' maritime claims in the East China Sea and the South China Sea; (3) after criticism of China's human rights record; and (4) as a consequence of foreign governments' arms sales to Taiwan (Chen & Garcia, 2016). For example, in September 2010, China enforced an unannounced export embargo on rare earth elements to Japan after the Japanese arrested a Chinese fisherman in the waters of the Senkaku Islands (Bradsher, 2010; Smith, 2012). At the end of October 2010, China allowed shipments of rare earth minerals to Japan again but with additional scrutiny and some delays (Barboza, 2010). The short-term Chinese embargo did not adversely affect Japan's sophisticated electronics sector, but signaled China's displeasure with Japan's action in disputed waters.

In October 2010, the Norwegian Nobel Committee awarded the Nobel Peace Prize for 2010 to Liu Xiaobo, a Chinese dissident, for his long and non-violent struggle for fundamental human rights in China (The Norwegian Nobel Committee, 2010). In retaliation for the announcement of the Nobel Peace Prize, China introduced a sanction in the form of a non-tariff barrier against Norwegian fresh/chilled whole salmon, starting a period of frigid political and economic relations between the two countries (Kolstad, 2016). According to Chen & Garcia (2016), from 2000 to 2010, Norway dominated the Chinese fresh/chilled whole salmon market, exceeding 80 percent of the total share in several years. This evidence suggests that Chinese consumers preferred Norwegian salmon to other exporters' salmon over a long period. After China allegedly implemented a trade sanction on Norwegian salmon, the share of salmon imported from Norway to China decreased to around 25 percent in 2014 (Chen & Garcia, 2016). The sudden and substantial fall of Norway's market share of salmon exports to China is unlikely explained by a change in Chinese consumers' taste away from Norwegian salmon or a decrease in China's national income. From 2010 to 2014, China's gross domestic product grew with impressive rates, by about 10.6 percent in 2010 and 7.3 percent in 2014 (World Bank, 2018a). Moreover, Chinese consumers still had an overwhelming preference for Norwegian salmon, having mostly been unaware of the difficult political relations between the two countries (Milne, 2013).

Salmon is one of Norway‘s main exports and an iconic symbol of the country. China, having become an increasingly important player in global trade, made its political intentions known through the application of non-transparent border measures aimed at delaying or limiting Norwegian exports. Thus, in May 2014, the Norwegian government declined to meet the Dalai Lama in its attempts to improve political and trade relations with China (Gladstone, 2014), showing that China managed to use targeted trade policies to pressure Norway in its diplomatic decisions. In other words, the Norwegian government made a concession to ease the political tension with China.

On the other hand, the Chinese sanction against salmon imported from Norway might have economic impacts on neighboring countries, for example, Vietnam. Vietnam started to import Norwegian salmon in 1997. Between July 1997 and January 2011, the quantity of Norwegian fresh/chilled whole salmon imported to Vietnam (18.8 tons per month on average) was much less than to China (320.9 tons per month on average). In April 2011, while China imported about 183 tons of fresh/chilled whole salmon from Norway, Vietnam suddenly imported more than 1.6 times that amount. This is the first time when Vietnam surpassed China in importing Norwegian salmon. However, Vietnam itself increased threefold its imports of salmon from Norway in March 2011. The change in Vietnamese salmon trade pattern in a few months time is unlikely to be explained simply as change in actual demand for Norwegian salmon. Also, it is noticeable that the price of Norwegian fresh/chilled whole salmon in Vietnam fluctuated between 46.08 NOK/kg and 47.03 NOK/kg from September 2010 to April 2011, without any sharp decreases. So, what can explain this change? Was the sudden increase in the quantity of Norwegian salmon imported to Vietnam consumed by domestic consumers, or was a large proportion of this volume transshipped and re-exported to China?

As there are no official data on the volume of exports of fresh/chilled whole Norwegian salmon from Vietnam to China, it is relevant to surmise that any transshipment of salmon is due to smuggling or other illegal deliveries of Norwegian salmon to China's market. In fact, in April 2018, Chinese customs uncovered smuggling operations of Norwegian salmon across the China-Vietnam border (Kynge, 2018). In the period from 2011 to 2017, the main trend in monthly data on Norway-China and Norway-Vietnam salmon trading is that when China's fresh/chilled whole salmon imports from Norway is low, Vietnam's is high, and vice versa. This could suggest that, to some extent, Vietnam's salmon market became integrated with China's salmon market sometime after the application of the sanction. If so, then the unofficial or illegal transshipment of salmon from Vietnam to China could represent a coping strategy among traders to bust the sanction.

This thesis studies the trade in fresh/chilled whole Norwegian salmon involving Vietnam, China and Norway, analyzing trade from July 1997 (when Vietnam began importing Norwegian salmon) through December 2018. The study will econometrically test whether Vietnam's imports of Norwegian salmon were driven by China salmon imports from Norway as a result of China's alleged sanction other than Vietnam's specific market situation. By using the monthly time series data from July 1997 to December 2018, I will regress models to test the causality between the alleged imposition of a Chinese sanction on Norwegian salmon and the quantity of fresh/chilled whole salmon exported from Norway to China and to Vietnam; and the impacts of other factors that influence the quantity of fresh/chilled whole salmon exported from Norway to Vietnam. Based on statistical evidence from the model, the study will specifically try to answer whether Vietnam's salmon market became integrated with China's coinciding with the period of the sanction.

This thesis is organized in six chapters. Chapter one, the introduction, motivates the general and specific problem, specifies the objectives of the study and research question. The second chapter provides some background, providing a detailed description of the salmon markets of Norway, China and Vietnam before and after the sanction. Theoretical context for analyzing market integration and the determinants of import demand, and a review of the related literature are provided in chapter three. The sources of the data used, and the definition of variables are described in chapter four, prior to the specification of a model and the methodology used to econometrically analyze the trade relationship(s) and market interactions between Vietnam and China. In chapter five, the results are reported on the outcomes of the model, providing insight into the findings and discussing their broader implications. Chapter six summarizes the study, highlighting the key findings and conclusions before addressing limitations of the study and making suggestions for further research.

2 Norwegian Salmon in the World Salmon Market

2.1 Salmon market

2.1.1 Salmon farming

Salmon is the common name for several species of fish of the family Salmonidae, while other species in the family are called trout (Marine Harvest, 2018). In the market, salmon is divided into two types, wild-caught salmon and harvested farmed salmon, and based where it is caught or harvested it is categorized as either Atlantic or Pacific salmon. Farmed salmon accounts for 75 percent of all the salmon consumed (Trilling, 2017). Farmed Atlantic salmon makes up more than 90 percent of the global farmed salmon market, and more than 50 percent of the total global salmon market (FAO, 2019a).

According to Marine Harvest (2018), the global demand for farmed salmon is increasing and will continue to rise for five reasons. Firstly, the growing global population leads to an increase in demand for food, and the development of emerging economies causes more consumers from middle classes who are willing to pay for food containing high-quality proteins. In that case, while wild-caught salmon is more limited, farmed salmon is a healthy solution to meet the demand. Secondly, salmon is nutritious and help to decrease the risk of cardiovascular disease and other health issues. Next, salmon can convert protein and energy to body muscle and weight more efficiently, compared to other food like chicken, pork and cattle. The fourth reason is that farmed salmon is produced in a more climate-friendly manner because of its low carbon footprint and freshwater requirement. Finally, the price of farmed salmon has decreased over the past few decades with the increased productivity of the industry. The global demand for salmon is growing in the pace such that the market can absorb an increase in supply of 6-7 percent per year without changing price levels (FAO, 2019b).

On the supply side, until 2018, Norway and Chile, respectively, have been the first and second largest Atlantic salmon producers in the world (Berge, 2018). Chile produces both Atlantic and Pacific salmon, but mostly Atlantic salmon (UN Comtrade, 2019). In 2018, the market shares of Norway and Chile were 54.7 percent and 25.5 percent, respectively, and their production constituted around 80 percent of the global salmon market. Each other producer’s production accounted for less than 8.0 percent of the market (Tridge, 2019).

According to International Salmon Farmers Association (2016), salmon farming has been the fastest growing food production sector in the world. Figure 2.1 shows the annual quantity of salmon produced in the world between 1997 and 2016. The quantity of salmon produced globally increased substantially from over 646 000 tons in 1997 to nearly 2.25 million tons in 2016, with the average annual growth rate of 13.1 percent (Fig. 2.1).

In 2016, the value of global salmon production reached US$15.4 billion, and 288 kilometers of ocean were used for salmon farming (International Salmon Farmers Association, 2016). However, in recent years, the growth rates of salmon farming industry have decreased to 5 percent growth from 2005 to 2017 as the industry's production level reached biological constraints (Marine Harvest, 2018).

For the remainder of this paper, salmon should be understood as fresh/chilled whole Atlantic and Pacific salmon if unless specified otherwise.

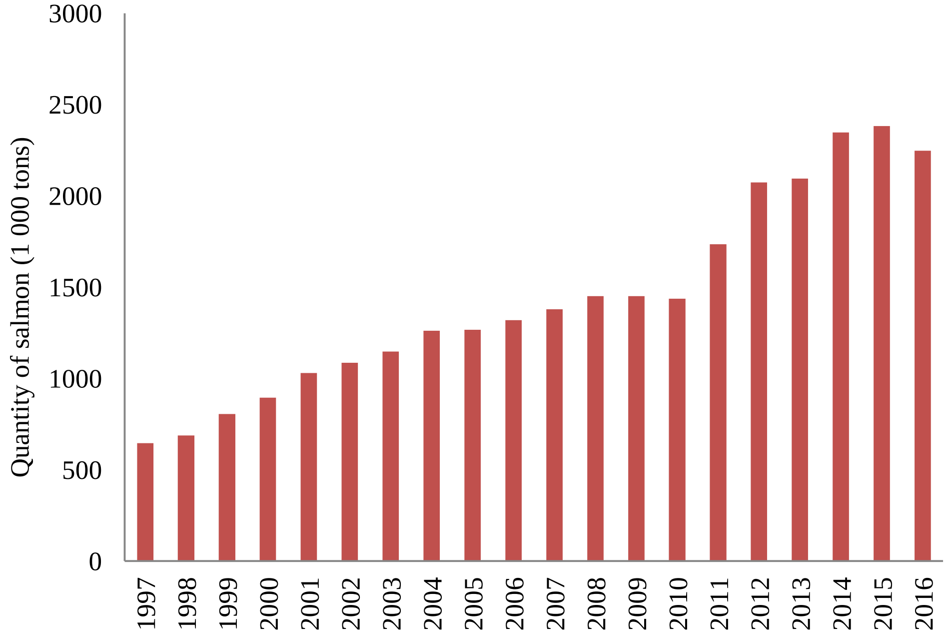


Figure 2.1. Global production of salmon, 1997-2016 (1 000 tons)
Source: FAO (2019a)

Norway has a 21 000 kilometer long coastline of clean and fresh sea water that is particularly suitable for the operation of sustainable aquaculture activities (Eurofish, 2019). Over the years, aquaculture has become a vital and iconic industry in Norway. Norway is ranked first among countries that have largest salmon farming industry and largest population of wild salmon (Sprire, 2019). For example, Norway's farmed salmon production accounted for about 55 percent of the world's farmed salmon production, and nearly a third of the total wild salmon has its natural habitat in Norwegian waters (Rakvåg & Sandøy, 2017). Therefore, Norway is producing more salmon than the United Kingdom, Chile, Canada, and the Faroe Islands combined (Smejkal & Kakumanu, 2018). Due to the limited quantity and high price of wild salmon, the main product of Norwegian salmon industry is Atlantic farmed salmon. In 2015, the salmon biomass in Norway more than twice outweighed the total Norwegian population (WHO, 2015). According to Statistics Norway (2018), Norway produced more than 1.2 million tons of salmon constituting 94.5 percent of aquaculture production in 2017. They also estimated the first-hand value of salmon in 2017 was around 61.6 billion NOK increasing by 2.5 percent compared to 2016.

From 2008 to 2014, Norwegian salmon farming experienced an exceptional growth with the annual growth rate of over 16 percent (Nøstbakken, 2016). Figure 2.2 demonstrates the trends in Norwegian farmed salmon production in value and quantity. Farmed salmon production increased from less than 200 000 tons every year during 1980s to about 1.3 million tons in 2014 (Fig. 2.2). Nøstbakken (2016) analyzed some of the drivers of Norwegian salmon farming's growth. Firstly, "new markets" mean that Norway implemented marketing project to introduce farmed Atlantic salmon into potential markets. Project Japan in the mid 1980s is a good example of this strategy. Secondly, the Norwegian salmon industry produced "new products" that are high-end salmon to target particular market and consumers. The third driver is "marker power". By imposing regulations to limit production, the prices of Norwegian farmed salmon were stable and not underestimated. Finally, "cost reductions" thanks to deregulation, economies of scale and innovation are behind the development of Norwegian salmon farming.

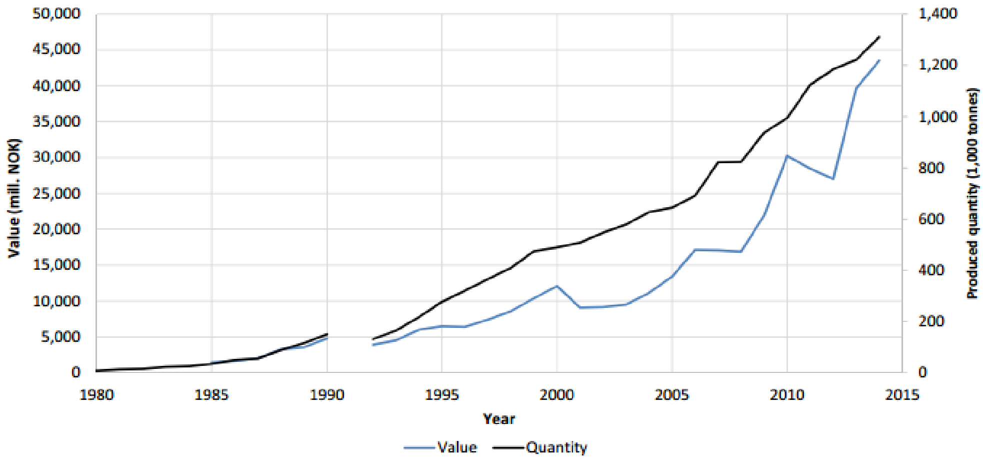


Figure 2.2. The annual value and quantity of farmed Norwegian salmon, 1980-2014 (value in million NOK, quantity in 1 000 tons)
Source: Nøstbakken (2016)

The deregulation in the early 1990s in Norway allowed larger firms to invest in specialized capital equipment and hire specialized labors, and limited the number of firms operating in the farmed salmon industry. This industry has become more consolidated since then (Nøstbakken, 2016). In 2016, the ten largest seafood firms owned 69 percent of salmon farms in Norway (Ling, 2018).

2.1.2 Salmon exporters

According to Tridge (2019), market concentration can be measured by the Herfindahl–Hirschman Index (HHI) that is calculated by summing the squares of the market shares of exporters within a market. A high HHI means that supplies are dominated by a few countries (Tridge, 2019). In 2016, salmon export market had a high HHI equal to approximately 38.8 percent (Tridge, 2019). High market shares of the main salmon exporters can explain the value of this index. Norway and Sweden are the two largest salmon exporters with the salmon export values of more than 5.8 and 3.2 billion US dollars ($), respectively, in 2016 (UN Comtrade, 2019). The market share of Norway and Sweden combined accounted for around 76.5 percent of the world salmon export market (UN Comtrade, 2019).

Figure 2.3 shows the volumes of salmon exported to the world by the top five exporters. Noticeably, Sweden is not a major salmon producer (Berge, 2018) but it ranked second among salmon exporters in 2016.

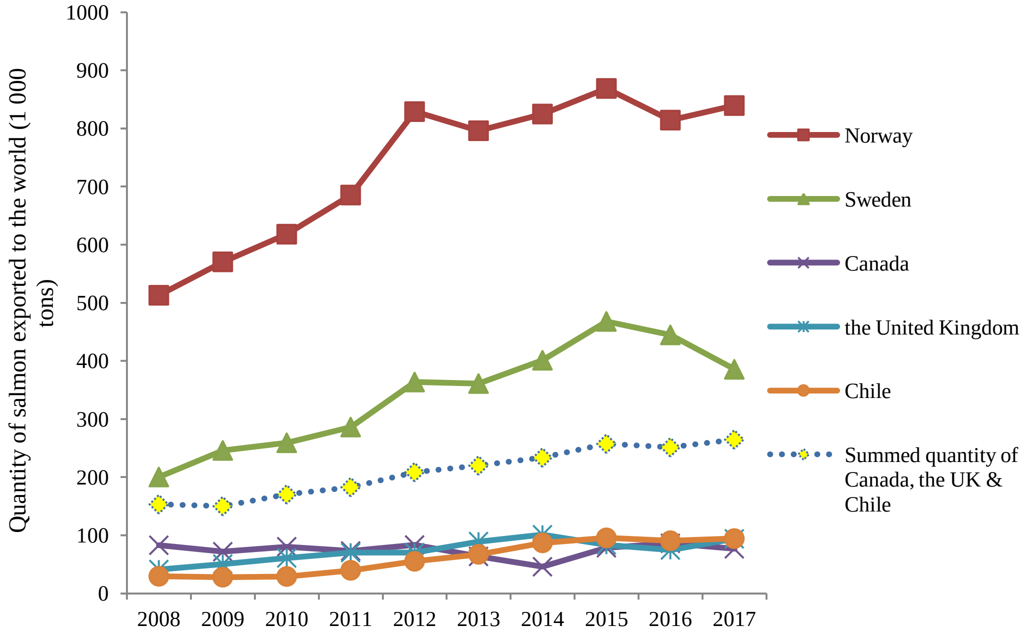


Figure 2.3. Salmon export volume to the world, by top exporter, 2008-2017 (1000 tons)
Source: UN Comtrade (2019)

Sweden acts as a “trade hub” for Norwegian exports re-exported within the EU (Pyanchenkova, 2017). During the ten-year period from 2008 to 2017, Canada, the United Kingdom and Chile were in the top five largest salmon exporters along with Norway and Sweden. However, the quantities of salmon exported from Canada, the United Kingdom and Chile were much smaller than the two leading exporters (Fig.2.3).

In figure 2.4, the unit price of salmon exported is presented for the principal exporters. The price of salmon on the export market fluctuated between 2008 and 2017 but the general trend increased. Salmon exported by the United Kingdom and Canada was more expensive than Chilean salmon, Norwegian salmon and salmon re-exported from Sweden.

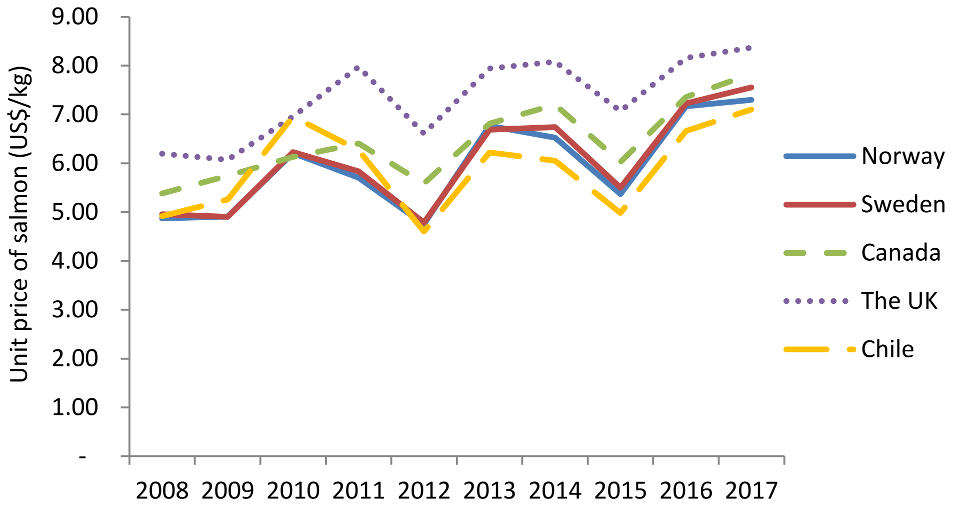


Figure 2.4. The unit price of salmon, by leading exporters, 2008- 2017 (US$/kg)
Source: UN Comtrade (2019)

The EU is Norway’s most important market for salmon exports (Norwegian Seafood Council, 2018a). In 2017, Poland, France, Germany and Finland are major importers of Norwegian salmon in the EU (UN Comtrade, 2019). Measured in volume, the Asian largest buyers of Norwegian salmon are Japan, Vietnam and South Korea in 2017 (Norwegian Seafood Council, 2018b). In North America, the USA is a large market for salmon exported from Norway (UN Comtrade, 2019).

Figure 2.5 demonstrates major markets for Norwegian salmon exports. In recent years, while the EU, the USA, South East Asia and Japan have been growing markets for Norwegian salmon, Eastern Europe (including Russia) has decreased their salmon import in value from Norway.

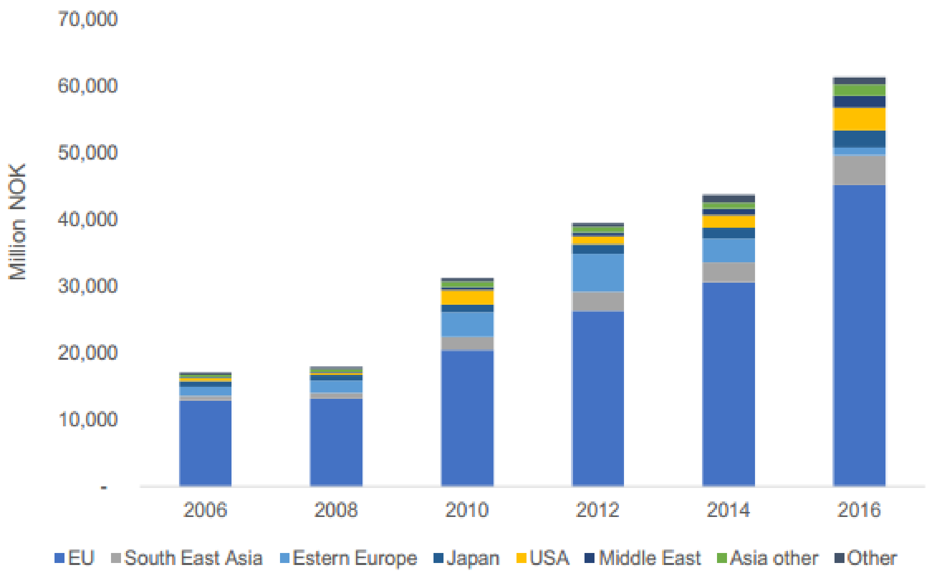


Figure 2.5. Norwegian salmon export value by market, 2006-2016 (million NOK)
Source: Rakvåg & Sandøy (2017)

Over the last decade, Norwegian salmon export's value has nearly tripled from approximately $2.2 billion in 2007 to $6.1 billion in 2017 (UN Comtrade, 2019). The price of salmon exported from Norway to the world increased by more than 1.5 times from around $4.5 per kg to $7.3 per kg (UN Comtrade, 2019). Table 2.1 shows the value, volume and unit price of Norwegian salmon exported globally between 2007 and 2017. In recent years, the quantity of Norwegian salmon exported has decreased, but the value has still risen because of the increases in price.

Table 2.1. Norwegian salmon export value, volume and unit price, 2007-2017

Year	**Value $ million**	**Volume 1000 tons**	**Unit price $/ton**
2007	2,242	4,940	4,539
2008	2,498	5,129	4,870
2009	2,800	5,704	4,909
2010	3,839	6,180	6,212
2011	3,909	6,854	5,704
2012	3,941	8,289	4,755
2013	5,386	7,960	6,767
2014	5,382	8,248	6,526
2015	4,668	8,688	5,372
2016	5,835	8,143	7,165
2017	6,124	8,393	7,296

Source: UN Comtrade (2019)

Noticeably, in 2015, the unit price of Norwegian salmon fell by more than $1/ kg compared to 2014. This decrease can be explained by the introduction of the Russian import ban on seafood. The ban leads to a significant volume of Norwegian salmon, which was produced for the Russian market, was relocated to the EU market (Pyanchenkova, 2017).

2.1.3 Salmon importers

The major markets for salmon are the EU, North America and Japan (FAO, 2019a). According to Pyanchenkova (2017), the main salmon importers in the EU are Sweden, Denmark, France, Poland and Germany, but Sweden and Denmark mostly just re-export Norwegian salmon (Pyanchenkova, 2017). In figure 2.6, the salmon imports by major importers are illustrated. In 2017, the quantity of salmon imported to Sweden and Denmark constituted about 27.2 percent and 4.5 percent of the total salmon imported by all countries.

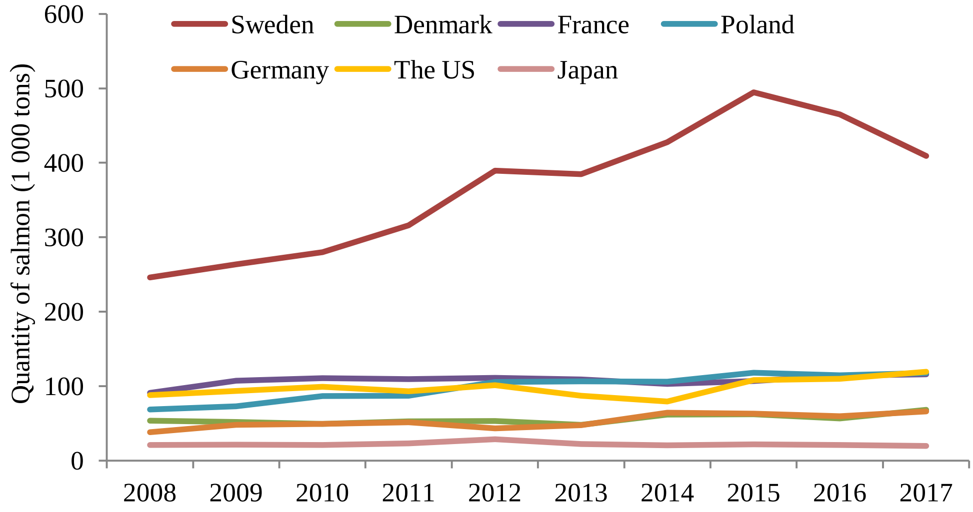


Figure 2.6. The annual quantity of salmon imported to selected countries, 2008-2017 (1 000 tons)
Source: UN Comtrade (2019)

Salmon imported to North America is mainly by the USA. US imports of salmon reached its record level and made up over 8.3 percent of the world's salmon imports in 2017 (UN Comtrade, 2019). Japan started to import salmon from 1980s thanks to a promotion project by a Norwegian seafood delegation (Norway Exports, 2011), and has become a major importer of salmon. In 2017, Japan imported nearly 20 000 tons of salmon, accounted for more than 1.3 percent of the world's salmon imports (UN Comtrade, 2019). Sweden far surpassed the rest of the word in the salmon imports over ten years from 2008 to 2017; however, the quantity of salmon imported by Sweden has decreased in recent years.

Denmark, France, Poland, Germany, the USA and Japan's salmon imports were relatively stable throughout this period (Fig. 2.6).

2.2 China's salmon consumption and import

2.2.1 China's salmon consumption

China has long history of consuming seafood in general, and has a rich culture in their traditional dishes made from fish (Wang, 2003). China now is the most populated country and the second largest economy in the world, making China a large and potentially profitable market for foreign seafood. In 2018, China consumed 37 percent of global production of seafood and aquatic products with high per capita seafood consumption of 44 kg per person per year (Harkell, 2018b).

The growing middle class and higher disposable income is facilitating consumers to buy higher quality food products. Thus, premium fish is becoming increasingly prevalent among middle-class Chinese consumers (Agriculture and Agri-Food Canada, 2017). The recent concerns of Chinese consumers about environmental and food-safety problems in China are creating strong demands for food sourced from clean and safe environments, especially imported products with good quality and reputation (Zheng, Wang, & Lu, 2018). Hu et al. (2014) found that many Chinese consumers showed their interest in raw fish such as high-quality salmon and tuna. An increased interest for Japanese food causes a growing salmon consumption in China; for example, 56 percent of salmon was consumed in Japanese restaurants in China (Rakvåg & Sandøy, 2017). Chinese consumers prefer Norwegian salmon over salmon from other countries (Chen & Garcia, 2016) because of Norwegian salmon's good and special taste (Rakvåg & Sandøy, 2017). Norwegian salmon is called "fish king in an icy ocean" in China, and has been increasingly favored by Chinese young people and middle-class population (Ma & Xiao, 2010). China's consumption of Atlantic salmon (in all forms) was approximately 90 000 tons in 2017. It is predicted to rise substantially in the future and exceed 240 000 tons by 2025 (Xiaojin, 2018).

2.2.2 China's salmon imports

In 2017, China imported more than 38 000 tons of salmon which was worth close to $360 million. The United Kingdom, Chile, Australia, Norway and Canada were the top five largest exporters in China's salmon market with market shares of 25, 23, 20, 7 and 4 percent, respectively (UN Comtrade, 2019). The UN Comtrade database does not record data on the Faroe Islands' salmon exports, but in 2016 its salmon export volume to China was actually nearly 9 000 tons, second only to Chile (Undercurrent News, 2017).

Prior to 2010, Norway dominated China's salmon market as Norway accounted for the predominant share of China's total salmon imports, rarely making up less than 70 percent of the total (Chen & Garcia, 2016). In figure 2.7, China's salmon imports from Norway and in total are illustrated. China imports of Norwegian salmon halved in 2011, from more than 9 600 tons in 2010. Since 2011, China's salmon imports from the rest of the world exceeded imports of Norwegian salmon.

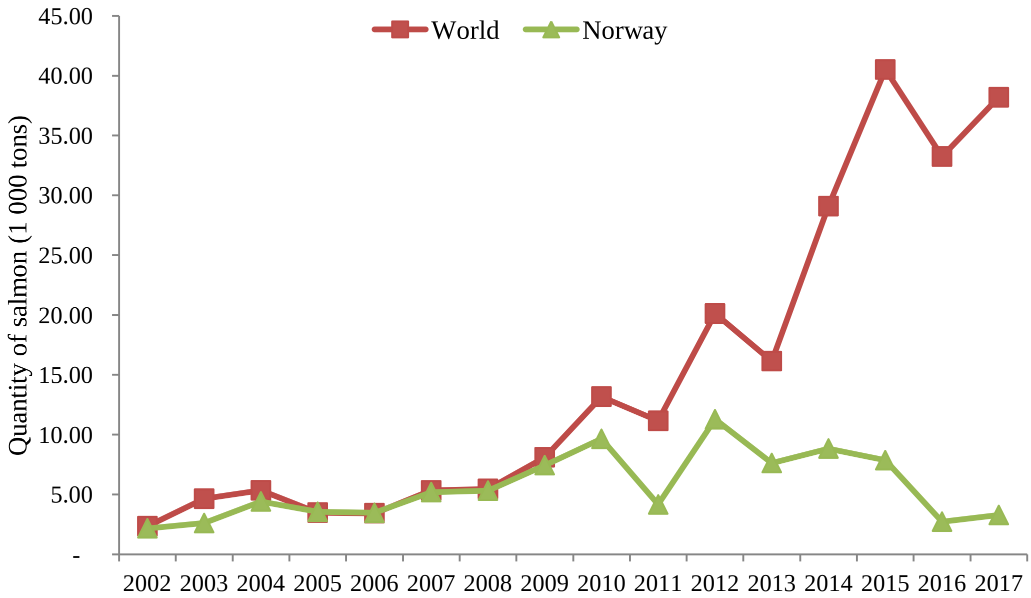


Figure 2.7. Total salmon imports into China and from Norway, 2002-2017 (1 000 tons)
Source: UN Comtrade (2019)

Norway has lost much of its market share in China's salmon market. Chen & Garcia (2016) argued that there was neither an obvious event explaining the sudden change in China's demand, nor a reduction in Norway's productive capacity, nor a change in Norwegian salmon's quality. In fact, as mentioned in section 2.1.1, Norwegian farmed salmon production grew at an average annual rate of over 16 percent between 1980 and 2014 (Nøstbakken, 2016).

Between 2010 and 2017, China imported nearly the tripled volume of salmon in total, but decreased its imports of Norwegian salmon by three times. Although, in 2012, salmon imports from Norway experienced a rebound in China's market, the gap between China's total imports and imports from Norway continued to widen (Chen & Garcia, 2016). These trends suggest that China has substituted away from Norwegian salmon, and has imported much more salmon from other countries. To which countries has Norway lost its market share? Figure 2.8 shows the quantities of salmon imports to China from major suppliers. The Faroe Islands, the UK and Chile have gradually taken Norway's market share in China's salmon market. Since 2014, Chile has become the market leader in China, followed by the UK and Faroe Islands.

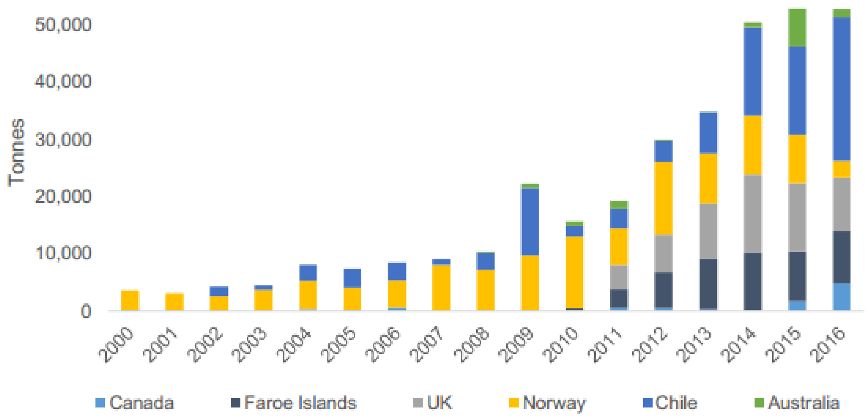


Figure 2.8. China's import volumes of salmon, 2000-2016 (tons)
Source: Rakvåg & Sandøy (2017)

2.3 Vietnam's salmon consumption and import

2.3.1 Vietnam's salmon consumption

Vietnam's population reached close to 96.5 million in 2018 (United Nations, 2019), making Vietnam rank 15th in the list of countries by population (Worldometers, 2019). The emerging middle class constituted 13 percent of the population, and is estimated to increase to 26 percent by 2026 (World Bank, 2018b). In 2017, seafood consumption per capita among Vietnamese consumers was 31 kg per person, and expected to reach 33-35 kg per person by 2020 as income and living standards increase (Vietnamnews, 2018). However, this number is still lower than China's seafood consumption per capita in 2018 (44 kg per person).

In recent years, Vietnamese consumers have been interested in salmon as healthy and premium seafood for consumption and giving (Thao, 2016). Vietnam farms salmon in some regions in the Northwest and Central Highlands. However, Vietnamese salmon is smaller and more expensive than foreign salmon. In addition, farmed salmon "made in Vietnam" is not sufficient to meet domestic demands (Zingnews, 2015b). Although there has not been any research comparing the quantity of Vietnamese salmon and imported salmon, consumers and restaurant owners in Ho Chi Minh city and Hanoi, the two most populated and developed cities in Vietnam, prefer imported salmon (Zingnews, 2015a). Overall, salmon consumption has the potential to increase in Vietnam.

2.3.2 Vietnam's salmon imports

According to UN Comtrade (2019), in 2017, Vietnam imported more than 24 000 tons of salmon of which Norwegian salmon accounted for about 96 percent. Between 2008 and 2017, Norway was the market leader during the whole period, dominating market shares at rates rarely below 90 percent. In figure 2.9, Vietnam's imports of salmon from main exporters are presented. Notably, Vietnam's salmon imports from Norway increased enormously by over 13 times from approximately 600 tons in 2010 to 8 000 tons in 2011(UN Comtrade, 2019). This trend cannot be explained either by population booming, or a sudden change in demand towards Norwegian salmon, nor a rapid rise in income, or a sharp decrease in the price of Norwegian salmon.

In fact, Vietnam's population growth rate was just 1.1 percent (World Bank, 2019b), and Vietnam's GDP growth rate was nearly 6 percent from 2010 to 2011 (General Statistics Office of Vietnam, 2019). The price of Norwegian salmon decreased by $1.8 per kg in 2011 but cannot likely be the reason for such an increase in imported volume. Between 2011 and 2013, the price climbed about $2.4 per kg; however, the imported quantity of Norwegian salmon still more than doubled. Moreover, an increase in consumer demand usually occurs in the longer run and does not experience a sudden sustained increase in quantity consumed in just one year, as occurred from 2010 to 2011.

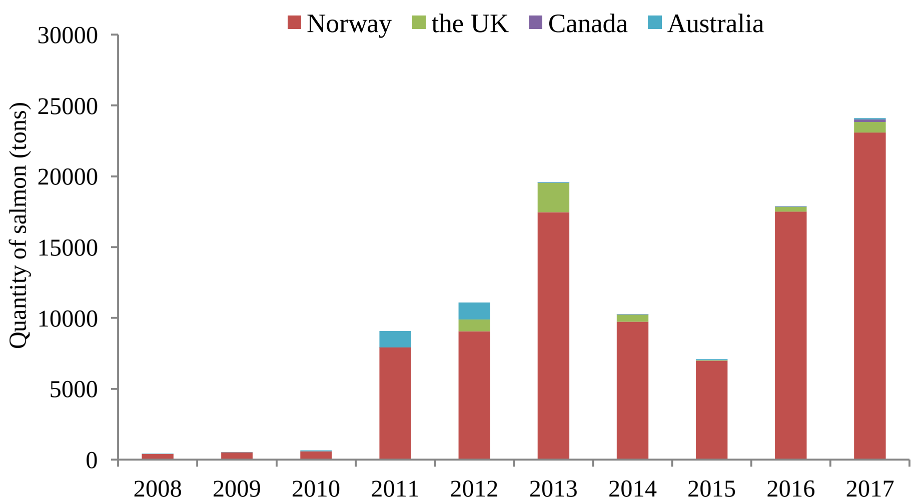


Figure 2.9. Salmon import into Vietnam by principal exporters, 2008-2017 (tons)
Source: UN Comtrade (2019)

This raises a question as to whether imports from Norway were really intended for the Vietnamese market or were to be re-exported. The official trade statistics do not record any re-exports by Vietnam. Thus, either salmon was imported for consumption in the domestic market or some of it was transshipped through smuggling. Figure 2.10 shows the annual volumes of Norwegian salmon imported by Vietnam and China from 1997 to 2018. In 2011, an increase by 13 times in Vietnam direct imports from Norway and a decrease by more than a half in China direct imports from Norway were reported.

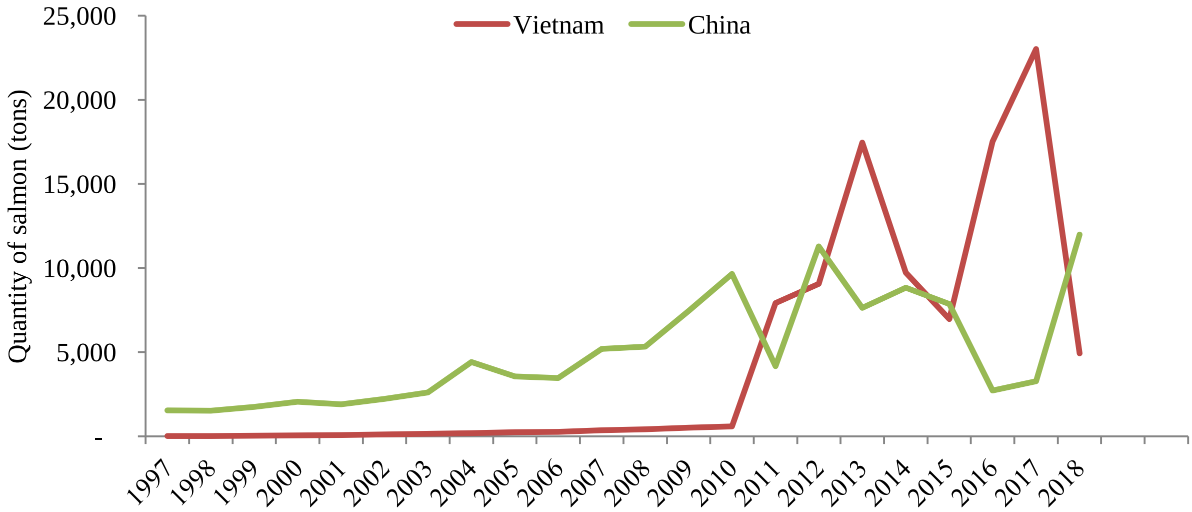


Figure 2.10. Vietnam and China's imports of Norwegian salmon, 1997-2018 (tons)
Source: Norwegian Seafood Council (2019)

2.4 China's alleged sanction against Norwegian salmon

2.4.1 Sanction period

In October 2010, the Norwegian Nobel Committee awarded the Nobel Peace Prize to Liu Xiaobo "for his long and non-violent struggle for fundamental human rights in China" (The Norwegian Nobel Committee, 2010). He was a Chinese dissident and was incarcerated by the Chinese government at the time he won the prize (Jacobs & Ansfield, 2010). While some countries including the USA, France and Germany called for his immediate release, China strongly protested the decision of Norwegian Nobel Committee. China emphasized that Liu Xiaobo is a criminal and awarding the prize to him is a complete violation of the principles of the Nobel Prize (BBC, 2010). Moreover, Beijing said that the prize would adversely affect the relations between China and Norway (Jacobs & Ansfield, 2010). Also, after the announcement of the prize, China cancelled a scheduled visit by a ministerial trade delegation to Norway. To express its displeasure, China allegedly imposed an economic sanction on Norwegian exports of salmon to China in the forms of discriminatory customs practices and regulatory border measures (Chen & Garcia, 2016). This event coincided with the unusual change in import volumes of Norwegian salmon to Vietnam and China. Perhaps, because of non-tariff barriers imposed by Chinese government, Norwegian exports of salmon to China dropped significantly in 2011. Could Norwegian salmon have been smuggled or illegally transshipped from Vietnam to China as a means to circumvent strict regulations at China's border?

China's reactions seemed to be effective as Norwegian leaders declined to meet the Dalai Lama in May 2014, who is considered an "unrepentant separatist" by the Chinese government (Gladstone, 2014). Becoming more assertive in international relations, on September 2014 and March 2015, China imposed a ban on Norwegian salmon's imports because of the virus ISA, infectious salmon anaemia, because it could harm the domestic aquaculture industry (Chen & Garcia, 2016). On December 2016, after six years of no political contact from 2011, Norway and China announced the full normalization of their relations (Regjeringen, 2016). More than one year later, on April 2017, Norwegian Prime Minister visited China. Norway and China signed a pact to resume free trade negotiations (Reuters, 2017). The visit expectedly led to the end of sanction period and gradually brought Norwegian salmon import volume back to its pre-sanction position in China's salmon market. After a month, a Norwegian delegation traveled to China to sign a new seafood trade agreement that comprised $1.45 billion worth of salmon exports to China by 2025 (Nordea Bank, 2017). As shown in figure 2.10, there was an increase in China imports of Norwegian salmon from the end of 2017 to 2018, which coincided with a decrease in imports into Vietnam.

2.4.2 Sanction implementation

There were no official declarations or statements from the Chinese governments that their new regulations were to target Norwegian salmon as retaliation against the 2010 Nobel Peace Prize (Rakvåg & Sandøy, 2017). However, according to Chen & Garcia (2016), China changed sanitation tests and veterinary inspections to explicitly target Norwegian salmon. For example, the Beijing Capital Airport Entry-Exit Inspection and Quarantine Bureau issued an order, dated 8 December 2010, required stricter checks on especially Norwegian fresh aquaculture products coming through Capital Airport (Chen & Garcia, 2016). On 28 January

2011, the Central Office of Quality Supervision, Inspection and Quarantine of the People's Republic of China issued an order entitled "General Notice on Strengthening Inspection and Quarantine of Imported Salmon" calling for more thorough sanitation and veterinary testing on imports of chilled farmed salmon generally (Chen & Garcia, 2016). This regulation seemed to be implemented in a non-discrimination manner (Chen & Garcia, 2016). But, Norway had dominant market shares in China's salmon market before the sanction period. Therefore, this order was actually implemented as a form of sanction against Norwegian salmon. Based on the results of stakeholders' interviews, Chen & Garcia (2016) stated that Chinese importers of Norwegian salmon started to experience constraints on the approval of import volumes since 2011. The limit of approved licenses for Norwegian salmon was 10 to 30 tons and was not applied to salmon from other countries (up to 300 tons) (Chen & Garcia, 2016). In addition, Norwegian salmon exporters could not make applications for new licenses before using up an existing quota (Rakvåg & Sandøy, 2017). Besides, Norwegian salmon was specially required to have health certificate for salmon that prove the absence of PD (pancreas disease) and ISA (infectious salmon anemia) which can harm China's rainbow trout farming (Rakvåg & Sandøy, 2017).

As can be seen from figure 2.10, the Chinese sanction succeeded to restrict Norwegian salmon direct exports to China from the beginning of 2011 to the end of 2017, except for a rebound in 2012. However, the volume of Norwegian salmon indirectly from Vietnam to China is not recorded due to smuggling or illegal transshipment. The Chinese government was almost certainly informed about that but they did not enforce a stricter border control between Vietnam and China (Chen & Garcia, 2016). By implementing a sanction on Norwegian salmon, China's intention was to signal dissatisfaction to Norway regarding its displeasure in a foreign policy matter (Chen & Garcia, 2016).

2.5 Smuggling of Norwegian salmon from Vietnam to China

One way for Norwegian salmon to go around China's sanction is through Hong Kong. Norwegian salmon was imported to Hong Kong, and then re-exported or legally-transshipped to China (Chen & Garcia, 2016). Chen & Garcia (2016) reckoned that about 21 percent of Hong Kong's imports from Norway were re-exported to China, on an annual average, from 2011 to 2014. Another way is to falsify country-of-origin certification of salmon, and this practice was admitted by one Hong Kong importer (Chen & Garcia, 2016).

Smuggling Norwegian salmon to China via Hong Kong and/or Vietnam was admitted by several stakeholders motivated by increasing difficulty of importing legally (Chen & Garcia, 2016). On April 2018, Chinese customs police uncovered a smuggling ring which illegally imported Norwegian salmon worth up to $98.4 million (Harkell, 2018a). This group engaged in smuggling Norwegian salmon from Vietnam to China, and its alleged ring leader is a Chinese woman holding Norwegian passport (Seaman & Harkell, 2018). One month later, on May 2018, the price of salmon in China market increased due to a rise in global prices and a decrease in the volume of salmon smuggled into China through Vietnam (Mereghetti & Harkell, 2018). It is possible that since 2018 China has lifted the sanction against Norwegian salmon without official announcement as when the sanction was imposed.

Although there is no information from the Vietnamese government, smuggling of Norwegian salmon into China's market is a likely explanation for the sudden increase in Vietnam's imports of salmon from Norway since 2011 until the end of 2017. Chen & Garcia (2016) reckoned that China's share of Norwegian salmon imports coming from Vietnam would amount to 32 percent of the total with the assumption that 95 percent of the Norwegian salmon imported to Vietnam was smuggled to China, on the 2007-2010 annual average, and the rest stayed in Vietnam.

3 Theory and literature review

3.1 Import demand

Import demand or excess demand is the willingness of importing nation to take various quantities of a specific commodity off of the world market, per unit of time, at all relevant prices, all else held constant (Garcia, personal communication, 2018). Import demand equals domestic demand minus domestic supply in the importing country. A traditional import demand function is specified as a function of price and real income (Senhad, 1998). However, the price determinant can be reflected by the price ratio of import goods relative to their close substitutes. Narayan & Smythr (2005), Emran & Shilpi (2008) and Hor, Keo, & Suttiprapa (2018) suggested other determinants of import demand such as exchange rates, policy and population. Generally, import demand (ID) is a function of real income, price ratio, exchange rates, policy and population. That is,

$$ID = f(Y, P\_ratio, FX, Pol, Pop) \tag{3.1}$$

where Y is real GDP, P_ratio is the ratio of the prices of commodity and its close substitutes, FX is the exchange rates of the currencies of importer and exporter, Pol is policy or government intervention and Pop is total population. In this thesis, I will focus on the first three determinants: real GDP, price ratio and exchange rate.

For simplicity, I assume that A is the importing country with α as its national currency, and B is the exporting country with β as its national currency. The commodity is q. Its close substitutes are q from other large exporters. Let us suppose that domestic supply of q in country A is constant over time. Therefore, the import demand for q only depends on the domestic demand of consumers in country A.

3.1.1 Real income

Real income is usually represented by real gross domestic products (real GDP). An increase in real income would positively affect import demand for a normal or superior good. For instance, if real income rises, consumers will have more money for consumption of imported goods, leading to an increase in import demand. Additionally, salmon is considered as premium seafood containing high-quality protein (a superior good). Therefore, consumers tend to demand more imported salmon as their income increases, and vice versa. Because this thesis focuses on salmon, I assume that q is a superior good.

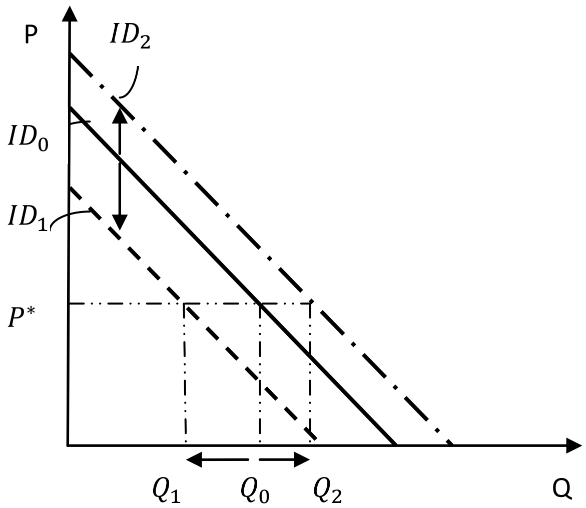


Figure 3.1. The effect of change in real income on import demand

In figure 3.1, at the beginning, the initial import demand of A is ID_0 corresponding with the quantity imported at Q_0. Given a stable price of q at P^*, if Y increases for whatever reason, the ID curve will shift to the right to ID_2, causing the quantity imported to increase to Q_2. Xie, Myrland, & Kinnucan (2008) investigated that a higher quantity of fresh Norwegian salmon is demanded due to an income growth between 1998 and 2005.

3.1.2 Price ratio

Suppose that price ratio equals to the price of q divided by the weighted average price of q from other large exporters.

$$P\_ratio = \frac{P}{\sum_i^n (P_i \times \frac{Q_i}{\sum_i^n Q_i})} \tag{3.2}$$

where P is the unit price of q from country B, P_i is the unit price of q from exporter i and Q_i is the quantity of q exported from the other i exporters.

An increase in P_ratio means that q from country B becomes increasingly expensive relative to q from other exporters. To maximize utility under a budget constraint, country A's consumers will substitute away from q exported by country B, and consume relatively cheaper q from other countries, leading to a decrease in import demand. A change in price ratio would cause a movement across the import demand curve, not shifting the curve.

Looking at figure 3.2, at first, the price ratio and quantity of q imported from country B are P_ratio_0 and Q_0 respectively. When price ratio rises to P_ratio_2, the import demand for q from country B will decrease to Q_2, and vice versa. Intuitively, an increase in price ratio would have a negative effect on the volume of q imported to country A.

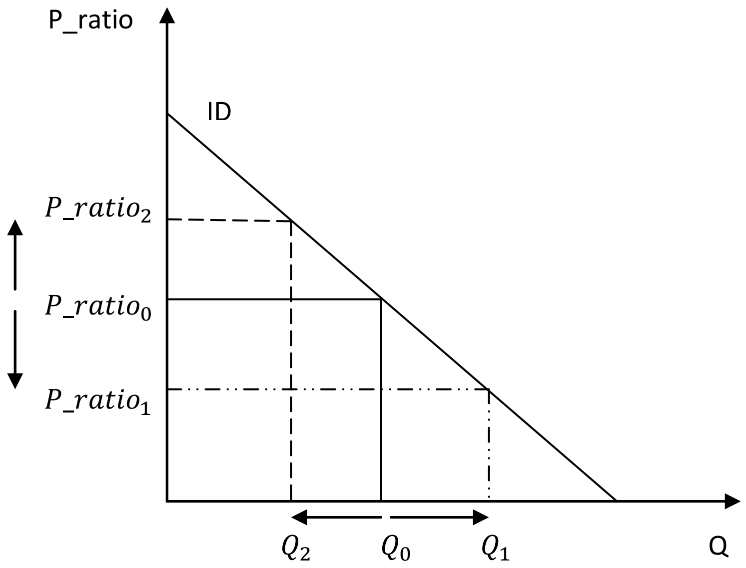


Figure 3.2. The effect of change in price ratio on import demand

3.1.3 Exchange rates

Suppose that exchange rate equals to how much α can be exchanged for one unit of β, denoted as β/α. A rise in exchange rates means a revaluation of β relative to α. The effect of a change in exchange rate on import demand is more complicated than above cases. Houck (1992) analyzed trade effect of exchange rate's changes in three-nation context, one importer and two exporters. For simplicity, under mentioned assumptions, I will explain how a change in exchange rate influences country A's import demand based on Houck's model.

Figure 3.3 shows the import demand for q from country B in β price (in the upper panel) and α price (in the lower panel). The ES curve is the export supply curve of country B. With a revaluation of β, β now commands more units of α. Thus, the import demand curve for q from country B in β price will shift to the left (from ID_0 to ID_1). Because the demand for q from country B decreases, the β price of q will fall (from P_β^0 to P_β^1). Although the β price decreases, the β revaluation process causes the α price to increase (from P_α^0 to P_α^1). Thus, country A's import demand for q from country B decreases from Q_0 to Q_1.

In the opposite case, a devaluation of β means that now less units of α is needed to exchange for one unit of β. As a result, the import demand curve for country B's q in β will shift to the right (from ID_0 to ID_2). In other words, country B faces an increasing demand for salmon, leading to a rise in the β price (from P_β^0 to P_β^2). Although the β price increase, the β devaluation process caused the price of q expressed in α to decrease (from P_α^0 to P_α^2). Therefore, country A demands a higher quantity of q exported by country B (from Q_0 to Q_2).

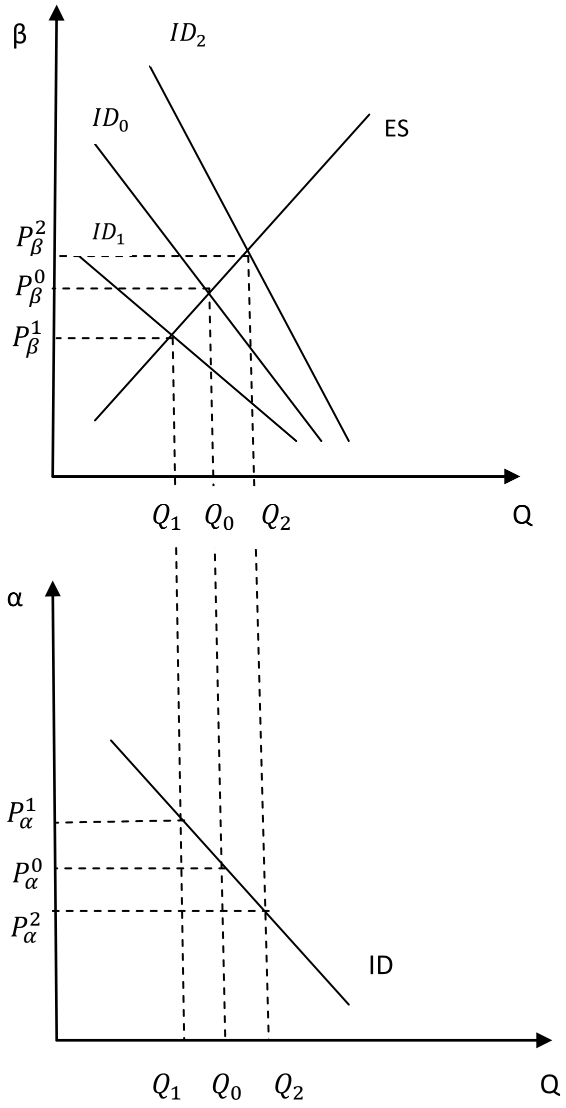


Figure 3.3. The effect of change in exchange rate on import demand

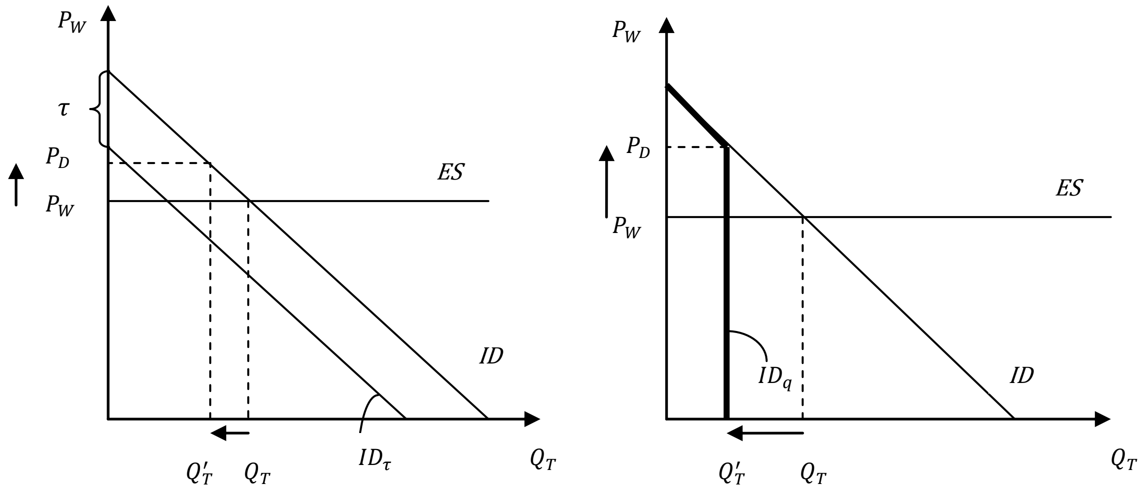
To summarize, the effects of an increase in the value of β would split between a fall in β price and a rise in α price, and negatively influence country A's import demand for q exported by country B, and vice versa. The literature found that an isolated 1% strengthening in the trade-weighted NOK reduces the Norwegian price by 0.39 percent, implying that exchange rate is a crucial determinant of farm prices (Xie et al., 2008).

3.2 Trade policies

The government uses trade policies to influence a country's exports and/or imports. Policy instruments to target exports includes export taxes and export subsidies. Both an export tax and an export subsidy distort the free-market flow of goods and services and reduce world welfare, and an export tax reduces the size of international trade as well (Appleyard & Field, 2014). In this thesis, I will focus on trade policies interfering with imports. Trade policies targeting imports can be divided into tariff barriers (or import tariffs) and non-tariff barriers. Import tariffs are applying in two manners, specific tariffs or ad valorem tariffs. Appleyard & Field (2014) defined that a specific tariff is an import duty as one that levies a fixed monetary tax per physical unit of the good imported whereas an ad valorem tariff is assigned as a constant percentage of the monetary value of one unit of the imported good. Non-tariff barriers are more diverse, and import quotas are the most common instrument. An import quota imposes a physical limit on the amount of the good that will be allowed into the country during a time period (Appleyard & Field, 2014). Berg (2017) analyzed other forms of non-tariff barriers including export bans to insure against domestic shortages, bureaucratic procedures to impede international trade, “buy domestic” regulations and local restrictions on foreign trade.

Why does the government interfere with trade? The government’s main objectives is (1) to increase government revenue, (2) to improve the country’s balance of trade (BOT) and terms of trade (TOT), (3) to increase employment, (4) to offset market imperfections, (5) to respond to foreign dumping and/or subsidy, (6) to protect infant industry and promote exports through economies of scale (Appleyard & Field, 2014). These objectives are related to economic benefits and/or advantages on international trade market. On the other hand, the government sometimes imposes policy instruments for non-economic purposes such as national defense when an industry is invaluable to a country during periods of war or national emergency (Appleyard & Field, 2014), or delivering a message of displeasure in political relations (Chen & Garcia, 2016).

In retaliation to the Nobel Peace Prize for 2010, China imposed stricter sanitation and veterinary testing on, and constrained the approved volume of salmon imports from Norway, which might have equivalent impacts as an import tariff and import quota, respectively (Chen & Garcia, 2016). As mentioned in chapter 2, China has been not among main markets for Norwegian salmon over the years. Thus, figure 3.4 illustrates the effects of an import tariff and import quota in theory in the case when the importer is a small country.



(a) Effect of a specific import tariff (b)Effect of an import quota

Figure 3.4. The effects of an import tariff and import quota

Let us suppose that the commodity is salmon, and Norway's export supply (ES) curve does not shift. Initially, China's import demand (ID) curve is ID, and P_w and Q_T are the world price and the quantity of Norwegian salmon imported to China, respectively. Without an import tariff and/or quota, P_w is also the domestic price of Norwegian salmon in China's market. In panel 3.4(a), if a specific import tax of τ is levied on salmon from Norway, ID curve will shift to the left to ID_τ, causing the price of Norwegian salmon in China to increase to P_D and the import volume to decrease to Q'_T. The impacts of an ad valorem import tariff on domestic price and quantity of import are the same as those of a specific import tariff. In the case showed in panel 3.4(b), China limits the import volume of Norwegian salmon at Q'_T as an import quota. This will raise the price of Norwegian salmon in China to P_D. In both cases, because China is a small importer, so the change in China's import demand would not influence the world price of Norwegian salmon.

3.3 Economic/Trade sanctions

Berg (2017) defined trade sanctions as trade restrictions that governments often use to punish or threaten certain countries over a variety of issues unrelated to international trade. Trade sanctions cause losses and gains. Sometimes the greatest costs are not bore by the countries that are targeted by sanctions, but by thirds countries and/or the sender country (Berg, 2017). In some cases, trade sanctions have succeeded to bring political changes in the target countries (Berg, 2017). According to Caruso (2003), the literature distinguishes between negative and positive sanctions. Negative sanctions are imposed to induce an economic damage to one or more countries. On the other hand, positive sanctions are taken as measures devoted to promote co-operation among some countries. To be sure, China's alleged economic sanction against Norwegian salmon is negative sanction. Thus, an economic/trade sanction should be understood to be negative hereafter if there are no further explanations.

Based on the objectives of sanctions, they are categorized into three groups (Caruso, 2003). The primary objectives are related to the actions and/or behaviors of nations which are targeted by the sanctions. The secondary objectives are concerned with the status, behaviors and expectations of the government who is applying the sanction. The tertiary objectives can be imposed under broader international considerations, related to the order of the whole international system, or some parts of it (Caruso, 2003). The trade sanction that China imposed on Norwegian salmon has the primary objective because they were applied as a political tool to retaliate against the decision of the Norwegian Nobel Committee in 2010.

From the number of countries involved, economic sanctions can be divided into unilateral and multilateral sanctions (Caruso, 2003). While the former are used by only one country against a targeting country, the latter are imposed by more than one countries (Caruso, 2003). In addition, Afesorgbor (2019) considered economic sanctions as threaten sanctions as well as imposed sanctions. Threatened sanctions are just a signal from the imposing country that it is willing to restrict trade flow, but they are not carried out ultimately. Otherwise, imposed sanctions are actually applied in reality. While imposed sanctions cause a decrease in the trade flow between the sender and the target, threatened sanctions cause a rise in the trade flow (Afesorgbor, 2019). Although China has never officially declared its sanction, China's authorities have already enforced stricter border measures to restrict salmon imports from Norway (Chen & Garcia, 2016). Thus, China's economic sanction is considered a unilateral imposed sanction with Norway as the target country.

The literature, looking at the object of sanctions, classifies three types of economic sanctions: boycotts, embargoes and financial sanctions (Caruso, 2003). A boycott is enforced to restrict imports of one or more products from the target country. An embargo is a restriction of exports or certain goods to the target country. Finally, financial sanctions limit or suspend lending and investing from the sender to the target, restrict international payment of the target and/or freeze foreign assets of the target economy (Caruso, 2003). Among those types, boycotts are usually criticized as ineffective. The main aim of a boycott is to cause damages to a particular sector or industry of the target country. However, the target country can find other markets for their exports, or indirectly export goods to the sender country through a third country to go around import controls (Caruso, 2003). Chinese economic sanction against Norwegian salmon is a boycott because China took stricter border measures to restrict salmon imports from Norway. Why did China choose salmon? The reasons are that China has reasonably close international substitutes for Norwegian salmon, and not less important, salmon is a vital and symbolic good of Norway (Chen & Garcia, 2016).

Trade sanctions rarely achieve their stated objectives, and sometimes make the situation worse (Berg, 2017). Effective economic sanctions must satisfy several conditions: (1) the goals of the sender country are limited; (2) the target country actually undergoes economic difficulties; (3) better relations between the sender and target countries as a result of sanctions; (4) sanctions are firmly implemented in a single step; (5) sanctions induce considerable costs to the target country; (6) the costs for the sender are modest; (7) sanctions are not accompanied by military actions; and (8) when few countries are involved in the sanctions (Hufbauer, Schott, & Elliott, 1990). Meanwhile, Hovi, Huseby, & Sprinz (2005) defined successful sanctions as the ones that influence the target country to make political concessions or make the target country's noncompliance impossible. From a political perspective, China's economic sanction on Norwegian salmon succeeded as Norway had made gestures to warm the relations with China. However, China's sanction probably was not economically effective. Norway lost its market share in China's salmon market, but Norway's exports could be reallocated to other markets without any net effect on Norway's salmon industry (Chen & Garcia, 2016). Additionally, some salmon producing firms which are located in the United Kingdom and the Faroe Islands are wholly or partly owned by Norwegian capital, so an increase in these firms' market share in China's market would not cause Norwegian capital much reduction in returns to that capital (Chen & Garcia, 2016). Additionally, there exists a "side effect" of economic/trade sanctions that is commonly known as sanction-bursting.

3.4 Sanction-bursting: transshipment and smuggling

Early (2009) analyzed the realist perspective and the liberal perspective to explain sanction-bursting. While the realist perspective considers trade as occurring among states, the liberal perspective focus on the roles of firms and individuals on determining trade flows. Under realist theory, sanction-bursting is the behavior of third countries. The specific actions of third countries depend on their relations with the sender country (the country that imposes trade sanctions) and the target country (to which the trade sanctions are targeted). The liberal theory explains sanction-bursting by economic considerations of firms and/or individuals engaging in trade. In other word, if economic/trade sanctions create profitable opportunities available to firms and individuals, they would pursuing their interests through sanction-bursting (Early, 2009). In the case of China's economic sanction on Norwegian salmon, Chen & Garcia (2016) emphasized that if consumer preferences for Norwegian salmon are strong in China, any import restrictions would motivate coping strategies by private sector agents to go around the barriers and bust the sanction.

Two common strategies of sanction-bursting by private sector agents are transshipment and smuggling. Miller, Kroodsma, Amos, Hochberg, & Roan (2018) identified transshipment as a practice occurring when two vessels meet to exchange cargo, supplies or personnel, often between vessels at sea and far from a home port. Meanwhile, Andriamananjara, Arce, & Ferrantino (2004) defined transshipment is the practice of routing an export shipment through an intermediate location before it reaches its final destination, also known as re-exporting. Transshipment helps to reduce shipping costs, take advantage of economies of scale and enhance the range of services or routes offered to consumers (Andriamananjara et al., 2004). On the other hand, transshipment raises some concerns over traceability and transparency in the seafood industry (Miller et al., 2018). In the case of economic sanctions, the sender country, for example, imposes a boycott on the imports of one or more particular commodities from the target country. If there are strong preferences for these goods in the sender country, firms or individuals would be involved in re-exporting or transshipment from third countries to circumvent border controls.

Smuggling is an illegal mean of moving commodities from one side of the border to the other (Bruns & Miggelbrink, 2012). Smuggling is distinguished by two types of behavior: the first relates to prohibited goods and the second to avoiding customs and duties on import and/or exports (Pedani, 2008). Smugglers take advantage of borders to benefit from differences in demand and supply, differences of taxation or differences in the legality of trading certain goods (Bruns & Miggelbrink, 2012). In the case of a boycott, smuggling could distort the market in the sender country, decrease the efficacy of the sanction and make trade statistics unreliable (Chen & Garcia, 2016). Relating to this study, smuggling Norwegian salmon through Vietnam-China borders might have occurred to go around China's non-tariff barriers against salmon from Norway. This is the second type of smuggling behavior, and can somehow connect Vietnam's and China's salmon markets.

3.5 Market integration

Market integration may be defined as the opening and development of trade between autonomous markets (before this time), and their integration into a single operative entity (Jacks, 2000). Thus, market integration may involve two or more countries. Jacks (2000) also noted that the simplest form of market integration's concept is essential ideas of the so-called the law of one price or price convergence. To specify, when inter-market trade takes place, the differentials in the price of goods and services will tend to lessen and ultimately disappear. The law of one price holds under three assumptions: (1) no abnormal shocks to the integrated market; (2) the existence of individuals who are able and willing to engage in arbitrage; (3) neglected transportation and transactions costs (Jacks, 2000). In the real world, these costs are high enough to not be ignored. But, we still can expect prices to converge up to the point where the price in one market equals to the price in another market plus the costs of transactions and/or transportation costs (Jacks, 2000). Li, Joyeux, & Ripple (2010) stated that in competitive markets with zero transportation and transactions costs, no trade barriers and where markets are connected to each other, a single price will hold in all market locations for identical products. If products are not identical, for example due to quality differentials, we would expect price ratios of differentiated products in geographically autonomous markets to converge (Li et al., 2010).

McNew (1996) defined market integration in the context of a price shock. If markets are integrated, a price shock will be perfectly transmitted between these markets. In contrast, if markets are not integrated, excess demand changes cannot be transferred spatially so that the price shock will not be shared between nonintegrated markets (McNew, 1996). Goletti, Ahmed, & Farid (1995) emphasized the action of traders, the infrastructure available for trading and policies affecting price transmission process in market integration. For example, if market A and B are integrated, and the price of good X in A is high due to scarcity, then good X will flow from B to A as the reaction of traders. This leads to the price in B to increase, and the price in A to gradually decrease. In the case of no interfering policies, market integration is more dependent on traders' strategies.

Vinuya (2007) argued that an integrated market would not allow the persistence of price differentials in the long run. If there are price movements, adjustments will commence to regain the convergence of prices in geographically separated markets. From the supply side, suppliers would shift supplies towards markets that pay higher prices to maximize their profits; and from the demand side, consumers would substitute away from expensive suppliers and look for suppliers with lower prices (Vinuya, 2007). The first behavior can reduce the price in the "expensive" market. On the other hand, the second behavior can increase the price in the "cheap" market. Consequently, those behaviors would bring prices to converge in the long term.

In the relation with this thesis, the statistical evidence of the flow of Norwegian salmon from Vietnam into China would suggest a long-run process of price convergence, implying the market integration of Vietnam's and China's salmon markets.

3.6 Literature review

In this section, the related literature on import demand will be firstly reviewed to predict the sign of import demand's determinants. Then the studies on sanction-bursting and market integration will be reviewed to foresee whether Vietnam, as a third country, could be affected by China's alleged sanction on Norwegian salmon through sanction-bursting; and to what extent Vietnam's salmon market could integrate with China's salmon market when China imposed import restrictions.

3.6.1 Studies on import demand

Xie, Myrland, & Kinnucan (2008) investigated the effects of exchange rate's changes on export prices of farmed salmon by extending the differential inverse demand system or the inverse Central Bureau of Statistics model to include exchange rates in the following form:

$$w_i \, d\ln\left(\frac{p_i^x}{P^x}\right) = a_i + b_i \, d\, lnQ + \sum_j h_{ij} \, d\, lnq_j + \sum_j c_{ij} \, d\, lnZ_j \qquad (3.3)$$

$$i = 1, \ldots, n$$

where p_i^x is the export price of good i in the exporter's currency, q_i is quantity of good i, Z_i is the exchange rate that converts the export price into the currency of the import price, $y = \sum_{i=1}^{n} p_i q_i$ is total expenditure, $w_i = p_i q_i / y$ is the expenditure share for good i, $d\, lnP^x = \sum_{i=1}^{n} w_i d\, lnp_i^x$ is the Divisia price index in the exporters' currencies; and $h_i = b_i - w_i$ is the scale effect that is assumed to decrease with budget share.

The model was estimated using monthly data on fresh salmon exports and prices from Norway, the United Kingdom (the UK), Chile and ROW (Rest of World) during the period between 1998 and 2005. Xie et al. (2008) estimated coefficients for the Divisia volume index and conclude that fresh Norwegian salmon is a superior good in international trade (expenditure elasticity greater than one). In other words, more fresh Norwegian salmon is demanded as incomes increases. In addition, estimating uncompensated own flexibilities, they found that an increase in exports from Norway brings about a larger depressing effect on Norway's export price than a similar increase from its international competitors. Because Norway dominates the salmon export market, this result is expected (Xie et al., 2008). In terms of exchange rate indices, Xie et al. (2008) concluded that an isolated 1% strengthening in the trade-weighted NOK decreases the Norwegian price by 0.39 percent, increases the Chilean price by 0.23 percent, and has no influence on the UK and ROW prices. The study supports the hypothesis that exchange rates are a critical influencing factor of farm prices. In case of farmed salmon, the prices of large exporting countries were found to be at least as sensitive to changes in relative domestic currency values as to changes in export volume (Xie et al., 2008). They also found incomplete exchange rate pass-through (absorption into export price) for Norwegian kroner and US dollar, and complete pass-through for Chilean peso and British pound. This suggests that producers in Norway and the ROW are less affected by short-run movements in relative currency values than are producers in Chile and the UK. The interpretations of incomplete pass-through is that export prices are "sticky", and may be influenced by market power and/or non-tariff barriers (Xie et al., 2008). The expectation is that a revaluation of NOK would have a negative effect on Vietnam's import demand through exchange rate's decreasing pressure on export price and increasing pressure on import price.

Xie, Kinnucan, & Myrland (2009) estimated a five-equation system using a general demand specification to investigate demand elasticities for farmed salmon in world trade. They segmented world demand into fresh and frozen, and fresh demand is distinguished by origin, Norway, Chile, the UK and Rest of World (ROW). The secondary objective of the study is to figure out the direct and spillover effects of Norwegian Seafood Export Council (NSEC)'s promotion efforts using the polynomial inverse lag (PIL) technique. The five-equation system includes four equations of four fresh salmon groups disaggregated by their origin, and an equation of undifferentiated frozen salmon aggregated because frozen salmon from different suppliers is relatively homogenous (Xie et al., 2009). They used monthly data on quantity and value of salmon, and promotion expenditures from 1998 to 2005. The estimation results carry some interpretations. First, there may be a structural change in the world trade in salmon. To specify, consumers may increasingly prefer fresh salmon from Chile, the ROW and frozen salmon over fresh salmon from Norway and the UK. This might not be applied to the case of China because prior to 2010, Norwegian salmon constituted continuously dominant shares in China's salmon market (Chen & Garcia, 2016). Second, the demand for farmed salmon in international trade is becoming less price elastic (Xie et al., 2009). For instance, the demand for frozen farmed salmon at the world level is price inelastic at - 0.37. Weighting elasticities of demand for salmon from Norway, Chile, the UK and the ROW, they imputed that global demand for fresh farmed salmon is slightly price elastic at – 1.02, compared with a former estimate of between – 2.38 and – 2.47 based on data from 1983 to 1988 (Xie et al., 2009). The demand for Norwegian salmon is price inelastic at – 0.87. Secondly, all the conditional income elasticities are positive and significant. Therefore, all salmon products gain benefits from increases in income in which fresh salmon from Norway gains the most. Only Norwegian fresh salmon is income elastic at 1.25. This means a change in income would disproportionally influence Norwegian producers (Xie et al., 2009). They gave an explanation that advertising programs by NSEC is to position Norwegian salmon as a superior good with a few good substitutes. Finally, NSEC's promotion efforts have affected the demand for salmon from all exporters except the ROW. However, commercial programs rose the demand for fresh salmon at the expense of frozen salmon (Xie et al., 2009). Vietnam's import demand for Norwegian salmon would be expected to increase as the price falls and/or real income increase. However, these changes in price and income would be of insufficient magnitude to explain sudden increases in Vietnam's imports of Norwegian salmon since 2011.

Kinnucan & Myrland (2005) analyzed the effects of income growth and tariffs on salmon prices, production and trade flows using an equilibrium displacement model of the world salmon market. There are several key findings in the article. Firstly, world imports of salmon will increase at about the same rate as world income in the long term (income elasticity equals to 1.02). In the short term, income growth will have smaller effects on imports as price rationing is more severe in the case of fixed domestic supplies. With stable supplies, total income elasticities decline from 0.89 in the long run to 0.67 in the short run for EU, from 1.06 to 0.98 for the US, from 1.72 to 1.69 for Japan, from 1.11 to 1.03 for ROW, and from 1.02 to 0.87 for the world. This suggests that world trade flows are income inelastic when the adjustment interval is one year or less (Kinnucan & Myrland, 2005). Second, an isolated change in income in one market results in a fall in imports in other market (Kinnucan & Myrland, 2005). As the dominant importer, the EU experiences the largest spillover effects. Next, price responses to income growth in the EU, the US, Japan and ROW are uniformly inelastic because import demand is more sensitive to price than to income (Kinnucan & Myrland, 2005). Fourthly, imports are favored by income growth more than domestic production is. Thanks to income growth, imports increase about three times faster than domestic production for the four markets combined e.g. the EU, the US, Japan and the ROW (Kinnucan & Myrland, 2005). Based on the relevant conclusions of the paper, Vietnam's import demand for Norwegian salmon is expected to be more income inelastic in the short run, and more sensitively influenced by a change in price than in income. Nevertheless, the elasticities are not expected to be greater than 2.0, so they would not be able to explain the sudden change in Vietnam's salmon trade pattern. Since 2011, Vietnam's import demand has been probably driven by external factors, for example China's alleged sanction on Norwegian salmon, other than Vietnam's specific market situation. My thesis is an attempt to study this problem.

3.6.2 Study on China's sanction on Norwegian salmon and sanction-bursting

Chen & Garcia (2016) combined personal interviews with stakeholders and examination of trade data in an attempt to understand the relation between the changes in trade patterns of Norwegian salmon and the application of stricter import controls. They found evidence to support that China's sanction restricting imports of salmon from Norway was in retaliation for the Nobel Peace Prize for 2010 being awarded to Liu Xiaobo, a Chinese dissident. Chen & Garcia (2016) argued that China, as an increasingly important and assertive player in international trade, imposed a partial boycott on Norwegian salmon in the form of non-tariff barriers that were targeted or discriminatorily applied on Norwegian salmon. China's sanction is subtle as they were not based on legislation and not officially stated. The subtle sanction is preferred by the Chinese government because they are easy to reverse in a separate, face-saving manner, minimizing diplomatic fallout or potential legal challenges at the WTO. However, the subtle sanction makes it difficult for China to prevent sanction-bursting for two reasons. Firstly, China faced a problem of finding a foreign ally to co-operate in impeding transshipment and smuggling from third countries. Secondly, the Chinese government could only interfere through official bureaus and state-owned firms' behavior, but not with private sectors agents' behavior in salmon trade.

From a political perspective, Chen & Garcia (2016) argued that China's sanction seemed to achieved its desired effect by affecting Norway's diplomatic policy in issues related to

China. The signal of China's displeasure sent to Norway also influenced other countries, for example, the UK and France. Because delivering a political signal is the main goal of China's sanction, the Chinese government did not really bother to prevent sanction-bursting. Chen & Garcia (2016) identified different mitigation strategies to burst China's sanction against Norwegian salmon: (1) source-shifting to non-Norwegian salmon, (2) mislabeling country of origin in wholesale/retail markets, (3) legal transshipments, (4) illegal transshipments (including smuggling from Vietnam), (5) port-shifting within China (importing salmon through airports with less strict border controls), and (6) synchronization of import license applications. Sanction-bursting caused China's salmon market to be distorted. Thus, the damages and costs have been borne mainly by China's salmon market and its consumers (Chen & Garcia, 2016). They also emphasized that smuggling of salmon into China via Vietnam had occurred for more than four years, and the actual volume of salmon imports from Norway to China had increased despite the sanction. Thus, if a statistical relationship between an increase in Vietnam's imports of Norwegian salmon and a decrease in China's imports is found during the sanction period, this would be statistical evidence of illegal trade or smuggling of salmon from Vietnam into China.

Chen & Garcia's article is of particular importance because it provided supporting evidence for sanction-bursting as the responses of market actors to a particular economic sanction, confirmed China's confidence and sophisticated technique in using economics tool for political purposes, and raised a question regarding what can be done as China becomes more assertive in its foreign policy and its use of trade sanctions.

3.6.3 Studies on market integration

Asche, Bennear, Oglend, & Smith (2011) used monthly data on shrimp prices by size class and import prices from June 1990 to December 2008 to conduct an econometric analysis of market integration in the shrimp industry. Focusing on the price of brown, pink and white shrimp, they found evidence of market integration that suggests the law of one price holds for this industry. The authors use the following equation to investigate market integration:

$$\ln P_{1t} = \alpha + \beta ln P_{2t} \tag{3.4}$$

where P_{1t} is the price in one market, P_{2t} is the price in another, α is a constant term that captures price differences and β indicates the relationship between the prices. They use an Engle and Granger test for size classes within each species and concluded that for all species, there is strong evidence that the prices move proportionally over time. Then, by using a

Johansen test, Asche et al. (2011) tested the relationships among the prices of the three species and the import price, and also found that the prices are close to proportional and the law of one price nearly holds. This is evidence of market integration. From statistical results, Asche et al. (2011) provided some policy implications. Firstly, market integration suggests that import restrictions do not cause differences between the domestic and import price, but lead to changes in trade patterns, for instance by switching to imports from non-named countries or of non-restricted shrimp. Secondly, if the farmed shrimp fisheries experience supply shocks from disease, market integration implies that the domestic wild-caught fishery will be able to replace supply from imports. However, if the shock is too large to be compensated by domestic supply, it could lead to the break-down of market integration. Finally, market integration suggests that in case of environmental supply shocks, the decrease in shrimp supply cannot be offset by an increase in price. Thus, shrimp producers suffer the resultant losses from supply shocks, but shrimp consumers are not affected. In the case of this thesis, not only was more salmon from countries other than Norway directly imported to China, but also was Norwegian salmon indirectly imported to China via Hong Kong and/or Vietnam. Thus, Chinese consumers might not be considerably influenced by China's alleged sanction on Norwegian salmon. For example, instead of buying Norwegian salmon in supermarkets, they could buy salmon from traders who sold salmon as Norwegian, or actual Norwegian salmon was imported through another mitigation strategy. In which case, a statistical relationship between a decrease in Norwegian salmon imports into China and a rise of Norwegian salmon imports into Vietnam could imply some extent of market integration.

Vinuya (2007) tested market integration and the law of one price in world shrimp markets. He used two datasets in his study. The first dataset includes aggregate data of product group at the three most important shrimp markets in the world, European Union (EU), Japan and the United States (US). Shrimp price data from Japan and the US were from July 1997 to June 2005, and the data from the EU were from January 1995 to December 2004. The second dataset includes data on wholesale shrimp prices by count size in Tokyo, New York and European wholesale markets. Price data from Tokyo wholesale markets were from January 1989 to March 2004, and the data from European wholesale markets were from January 1989 to January 2000. Using a co-integration based test of market integration for the first dataset, Vinuya (2007) found consistent evidence supporting market integration in world shrimp markets due to a long-run relationship among prices. With the second dataset, at a disaggregated level, there was also evidence of convergence in all possible combinations of price series in the three wholesale markets. Interestingly, these findings were all the condition of different tariff levels in different markets. The important implication of this study is that the combination of exporters' and consumers' behaviors would dampen the impacts of tariffs. For example, import tariffs that increase the domestic price of shrimp would only have short-term effects. Exporters reallocate their supplies to the markets that offer higher prices. On the other hand, consumers substitute away from higher priced imports, and look for exporters who offer lower prices. This behavior gradually brings prices back to convergence in the long run. Relating to China's import restrictions on Norwegian salmon, if there is statistical evidence that volume of imports into China is inversely relate to volume of imports into Vietnam, then stakeholders' strategies and consumer behavior might neutralize the trade effect of China's alleged sanction.

Nielsen, Smit, & Guillen (2009) investigated market integration between fish species in Europe. They statistically tested two hypotheses: (1) the European fish markets for categories of similar species are integrated, and (2) markets for fresh and frozen fish are not integrated. Nielsen et al. (2009) used monthly data on the European supply of 23 fish species in volume, values and unit prices from January 1995 through December 2005. They found that the first hypothesis is true for fresh fish, and also for frozen fish to some extent. For the second hypothesis, their findings show no indication of integration of the market for fresh and frozen fish other than salmon. In other words, only markets for fresh and frozen salmon are integrated. Therefore, EU import restrictions on Norwegian salmon only cause frozen salmon to be imported from other countries (Nielsen et al., 2009). Because the thesis puts emphasis on fresh Norwegian salmon, the expectation is that markets for fresh salmon imports would be integrated to some degree.

In the next chapter, econometric models will be constructed to see if the results match with the expectations that have been made based on theories and empirical research in this chapter.

4 Modeling and data

4.1 Variables and data processing

Table 4.1 briefly introduces six variables that are used for the regression analysis. This study uses monthly data from July 1997 (when Vietnam started to import salmon from Norway) to December 2018, so each variable has 258 observations in total. The monthly quantity in kg of Norwegian salmon imported to Vietnam is $vnvol$ and to China is $cnvol$. The data on volumes and values of Norwegian salmon imported to Vietnam and China were provided by Norwegian Seafood Council.

Table 4.1. Summary of variables

Abbreviation	**Name**	**Type**	**Source**
$vnvol$	Volume of Norwegian salmon imported to Vietnam	Quantitative variables	Norwegian Seafood Council
$cnvol$	Volume of Norwegian salmon imported to China		Norwegian Seafood Council
$mongdp$	Vietnam's monthly real GDP		World Bank, UN FAO
$pratio$	Price ratio of Norwegian salmon relative to other salmon		Norwegian Seafood Council, UN Comtrade, Statistics Canada, UK Trade Info
fx	Exchange rate (NOK/VND), monthly average		Norges Bank, IMF
$sanc$	China's alleged sanction on Norwegian salmon	Dummy variable	Based on empirical research and data on direct imports

The real GDP of Vietnam by month is $mongdp$. Because monthly data on GDP were not available, $mongdp$ was calculated by dividing annual nominal GDP by 12, then dividing by the monthly CPI. To specify, the following formula was used to calculate $mongdp$:

$$mongdp = \frac{GDP_j}{12 \times CPI_k} \times 100 \tag{4.1}$$

where GDP_j is Vietnam's nominal GDP in year j and CPI_k is Vietnam's CPI in the month k ($k = 1, \ldots, 12$) of year j with 2010 as the base year, $mongdp$ is in US$. To calculate Vietnam's real GDP by month, the data on annual nominal GDP and monthly CPI were collected from World Bank and UN FAO, respectively.

Among five quantitative variables, $mongdp$ is the least reliable for two main reasons. Firstly, as GDP is not recorded monthly, the calculation is just a convenience, and does not reflect the actual data. Secondly, the definition of GDP is controversial, especially in developing countries. According to World Bank (2019), GDP, measured in current US$, is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. In Vietnam, it is a common practice that small and medium producers do not register their operations, and as a result, do not pay taxes. Thus, the value of their products is excluded from GDP, and considered as part of informal economy. The Vietnamese government plans to capture the value of the informal economy when calculating GDP in 2020, but this decision raises some arguments about its feasibility (Phuong, 2019). Therefore, GDP growth might not sufficiently reflect the change in income of Vietnamese consumers. However, the data on annual GDP are available and widely used as the indicator of national income.

The price ratio of Norwegian salmon to salmon from other main exporters is $pratio$, and equals to the unit price of Norwegian salmon divided by the weighted average price of salmon from other suppliers. The formula to compute $pratio$ is as follows:

$$pratio = \frac{P_{NOR}}{\sum_{i=1}^{n} P_i \times \frac{Q_i}{\sum_i^n Q_i}} \times 100 \tag{4.2}$$

where P_{NOR} is the unit price of Norwegian salmon imported to Vietnam, P_i and Q_i is the unit price and quantity of salmon exported to the world from country i, $pratio$ is in percent.

The NOK unit price of salmon imported to Vietnam from Norway is calculated by taking monthly import value divided by monthly volume. The exchange rates of NOK relative to US$ were provided by Norges Bank, and were used to transform the NOK price into the US$ price.

The monthly data on volume and value of salmon exported to the world by principal suppliers are available on UN Comtrade only from January 2010 to December 2018. Thus, for each month in this period, the prices of salmon exported to the world from five largest exporters were collected to calculate the weighted average price. For the months from July 1997 to December 2009, the data on prices of salmon exported by Canada and the UK were gathered from Statistics Canada and UK Trade Info, respectively, and were used to compute the weighted average price.

The value of Norwegian kroner (NOK) relative to Vietnamese dong (VND) is fx. The exchange rate (NOK/VND) equals to the exchange rate (USD/VND) divided by the exchange rate (USD/NOK). The data on exchange rates of USD relative to VND and USD relative to NOK were obtained from IMF and Norges Bank, respectively.

The last variable, $sanc$, is the dummy variable that takes the value of 1 from the first month that China's alleged sanction actually influenced Vietnam salmon imports from Norway, and takes the value of 0 for the months before that. A decision on the value of sanction dummy requires some analysis. On December 2012, China took the first step of enforcing stricter border controls on Norwegian salmon (Chen & Garcia, 2016). Then, the volume of Norwegian salmon imported to China decreased by more than three times in January 2011. On the other hand, the volume of Norwegian salmon imported to Vietnam increased by more than threefold in March 2011. This could be because private sector agents might have needed some time to react to the sanction, particularly because China never formally announced the sanction. Once the sanction took effect, Chinese importers would begin seeking sanction-bursting strategies, for example, smuggling. The month when the sanction started might be the structural break that changes the relationship between the import volumes of Norwegian salmon to Vietnam and to China. Due to the structural break, the coefficients of the model do not remain the same during the period of study (Gujarati, 2003). From the perspective of Vietnam, the month should be March 2011. In other words, the dummy variable, $sanc$ takes the value of 1 for the months from March 2011, and takes the value of 0 for the months before March 2011.

All of five quantitative variables were transformed into the logarithmic form because it is convenient and easy to interpret (Tang, 2003). The models work with $lvnvol$, $lcnvol$, $lmongdp$, $lpratio$ and lfx that are the natural logarithm of $vnvol$, $cnvol$, $mongdp$, $pratio$ and fx.

4.2 Modeling

4.2.1 Test for stationarity of variables

In estimations using time series data, it is important to check whether the series are stationary or non-stationary because the regression of a non-stationary series on one or more non-stationary series would be a spurious or non-sense regression (Gujarati, 2003). Thus, all variables are tested for stationarity using an augmented Dickey-Fuller test. The null hypothesis of the test is that the series has a unit root or is non-stationary. As can be seen from table 4.2, the augmented Dickey-Fuller tests for all five quantitative variables yield p-values greater than 0.05. Therefore, we fail to reject the null hypothesis at the 5% level of significance. In other words, the five original series are non-stationary at the 5% level of significance, and we need to take the first differences to make them stationary.

Table 4.2. Results of Augmented Dickey-Fuller tests

Variable	Test statistics	p-value
Test for variables in level		
$\boldsymbol{lvnvol}$	-1.416	0.5745
$\boldsymbol{lcnvol}$	-2.057	0.2621
$\boldsymbol{lmongdp}$	-1.676	0.4436
$\boldsymbol{lpratio}$	-2.027	0.2750
$\boldsymbol{lfx}$	-1.589	0.4892
Test for variables in difference		
$\boldsymbol{dlvnvol}$	-4.431*	0.0003
$\boldsymbol{dlcnvol}$	-4.990*	0.0000
$\boldsymbol{dlmongdp}$	-3.767*	0.0033
$\boldsymbol{dlpratio}$	-5.119*	0.0000
$\boldsymbol{dlfx}$	-4.847*	0.0000

Note: * and ** represent significance at the 1% and 5% levels respectively

The first differences of $lvnvol$, $lcnvol$, $lmongdp$, $lpratio$ and lfx are $dlvnvol$, $dlcnvol$, $dlmongdp$, $dlpratio$ and $dlfx$, respectively. An augmented Dickey-Fuller test was also used to test for stationary of first differences. The results of this test are shown in table 4.2. All p-values are much smaller than 0.01. So, we can reject the null hypothesis of unit root, or first differenced series are stationary at the 1% significance level. The 1%, 5% and 10% critical values are -3.462, -2.880 and -2.570, respectively.

4.2.2 Hypotheses

China has never admitted to imposing sanction on Norwegian salmon and the sanction was never officially declared or established in law. Additionally, re-export and legal transshipment of salmon into China from Vietnam are not recorded. However, the practice of smuggling Norwegian salmon from Vietnam to China was admitted by interviewed stakeholders (Chen & Garcia, 2016) and discovered by Chinese customs authorities on April 2018 (Harkell, 2018a). As stated in chapter 2, Vietnam’s salmon import from Norway increased by three times in volume in March 2011, and has fluctuated around a higher level since then. Thus, if a statistical link between the volume of Norwegian salmon imports to Vietnam and to China is found, we can provide an explanation for Vietnam’s strange behavior in salmon imports from Norway since March 2011.

In trade theory, real income, price ratios and exchange rates are the main determinants of import demand. However, they are not expected to be able to explain a sudden change in Vietnam’s salmon imports from Norway. The point of the study is about statistically demonstrating that Vietnam’s import demand for Norwegian salmon is driven by factors other than Vietnam’s specific market situation and more driven by China’s alleged sanction. Therefore, there are two hypotheses to be tested: (1) the changes in real income, price ratio and exchange rate do not statistically explain the change in Vietnam salmon imports from Norway after the sanction, (2) the volume of Norwegian salmon imports to China is inversely related to the volume of Norwegian salmon imports to Vietnam due to China’s alleged sanction. If the second hypothesis is true, then it can give statistical evidence of market integration of Vietnam’s and China’s salmon markets where consumers’ demand and traders’ profit-maximizing activities give rise to smuggling as a sanction-bursting strategy.

To examine the first hypothesis, a model of Vietnam’s import demand function is estimated. Based on theories discussed on chapter 3, real income is expected to have a positive sign while the price ratio and exchange rate are expected to have negative signs. To test the second hypothesis, the dummy variable, sanction, will be used to test for the structural break that changes the parameters of lagged Vietnam’s import volume and China’s import volume. Then, the regressions of Vietnam’s import volume on its lags and lags of China’s import volume will be run for the spans before and after the sanction. The expectation is that the change in China's import volume negatively affects the change in Vietnam's import volume after the sanction, but not before the sanction.

4.2.3 Estimation of Vietnam's import demand for Norwegian salmon

An autoregressive Distributed Lag (ARDL) model is adopted to model Vietnam's import demand function. Vietnam's import volume is the dependent variable. The real income, price ratio and exchange rate are the independent (explanatory) variables. The model includes lags of both dependent variable and independent variables. In economics, the dependence of the dependent variable on explanatory variable(s) is rarely instantaneous but, very often, with a lapse of time (Gujarati, 2003). Thus, including lag(s) of real income, price ratio and exchange rate is reasonable. In addition, sometimes, the value of dependent variable from a previous time influences its value at a current time. So, lag(s) of Vietnam's import volume should be included as well. The estimation method is OLS (ordinary least squares).

4.2.3.1 Lag length selection and ARDL model estimation

Serial correlation happens when the error term at current time is correlated with its lags. In time series regression, one of main causes of serial correlation is that we neglect the lag terms of variables in our regression, and they are captured by the error term. So, the error term will reflect a systematic pattern as it contains the influence of lags of variables, resulting in autocorrelation in the error term (Gujarati, 2003). Therefore, a remedy to correct for serial correlation is adding lags of dependent and independent variables into the model, or using ARDL model. If enough lags are included, the model is dynamically complete and, there is no serial correlation in the error term (Kebede, personal communication, 2017).

To choose the optimal lag length for ARDL model, a model without lags is estimated first as:

$$dlvnvol = \alpha_0 + \alpha_1 \times dlmongdp + \alpha_2 \times dlpratio + \alpha_3 \times dlfx + u_1 \quad (4.3)$$

where $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ are unknown parameters and u_1 is the error term. Then, I tested for serial correlation (autocorrelation) of the error term or the residuals, using the Breusch-Godfrey Lagrange Multiplier (LM) test. The null hypothesis is that there is no serial correlation in the residuals. As can be seen from table 4.3, the p-values are lower than 0.05. Thus, we can reject the null hypothesis, or state that the residuals are serially correlated at all six lags at the significance level of 5%.

Table 4.3. Result of Breusch-Godfrey LM test for the residuals of model without lags

lags(p)	chi2	df	Prob > chi2
1	13.526	1	0.0002
2	13.817	2	0.0010
3	13.895	3	0.0031
4	13.900	4	0.0076
5	14.167	5	0.0146
6	16.467	6	0.0115

The lag length was chosen by using a correlogram and information criteria. Figure 4.1 is the correlogram that graphically illustrates the result of autocorrelation tests for 40 lags of the residuals. The figure shows that lag 1 is outside the Bartlett's formula for MA(q)[1] 95% confidence bands, suggesting the lag length of 1.

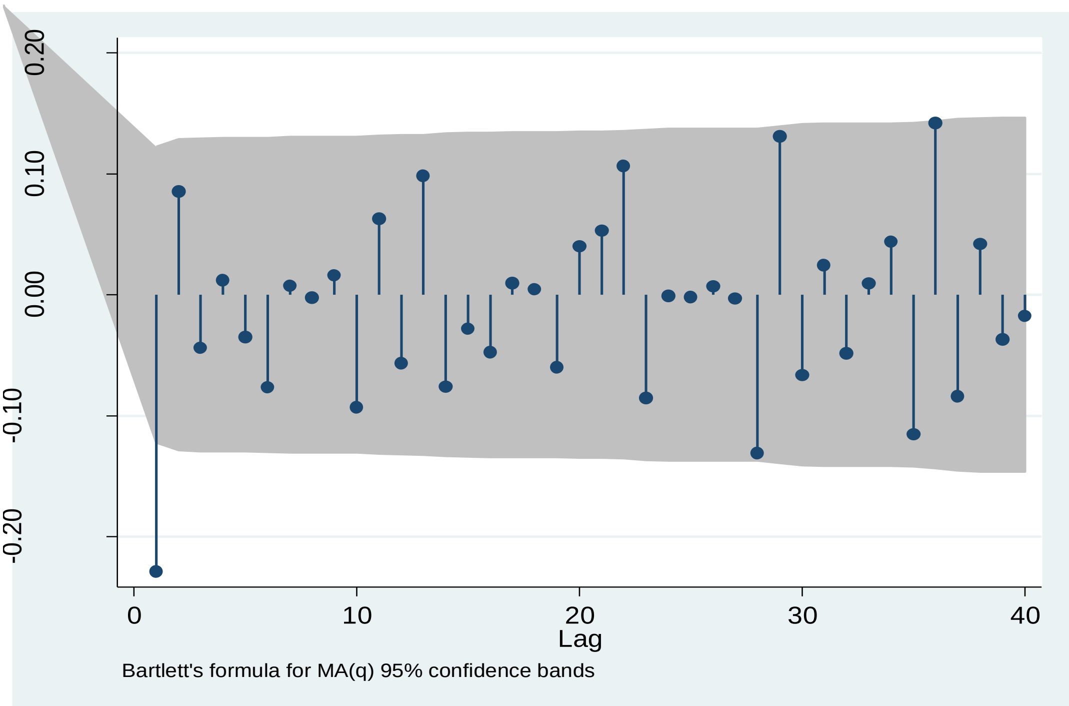


Figure 4.1. Correlogram of autocorrelation test

Information criteria, Akaike information criterion (AIC) and Schwarz's Bayesian information criterion (SBIC), are often used to decide the lag length (Greene, 2003). The model of p lag(s) that yields the lowest AIC and BIC should be chosen. Table 4.4 presents the results of AIC and SBIC for lags from 1 to 6, suggesting the optimal lag length is 1. Based on the suggestions of correlogram and information criteria, the optimal lag length of 1 lag is

[1] Moving-average process of order q (Queen Mary University of London, 2019)

selected to estimate the ARDL model. The ARDL model with 1 lag is shown in the following equation:

$$\begin{aligned} dlvnvol_t = \beta_0 + \beta_1 \times dlvnvol_{t-1} + \sum_{i=0}^{1} \beta_{2i} \times dlmongdp_{t-i} \\ + \sum_{i=0}^{1} \beta_{3i} \times dlpratio_{t-i} + \sum_{i=0}^{1} \beta_{4i} \times dlfx_{t-i} + u_2 \end{aligned} \tag{4.4}$$

where $\beta_0, \beta_1, \beta_{2i}, \beta_{3i}, \beta_{4i}$ are unknown parameters, u_2 is the error term. The model was then estimated by OSL estimation method.

Table 4.4. Lag length selection criteria for ARDL model

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-89.4085				.120333	.720387	.726039	.734432
1	-83.6002	11.617*	1	0.001	.11581*	.682073*	.693378*	.710165*
2	-83.4741	.25222	1	0.616	.116619	.689037	.705994	.731174
3	-83.4107	.12685	1	0.722	.117493	.696499	.719109	.752682
4	-83.4106	.00011	1	0.992	.118433	.704467	.732729	.774695
5	-83.3146	.19212	1	0.661	.11929	.71167	.745584	.795944
6	-82.104	2.4211	1	0.120	.119091	.709992	.749558	.808312

Note: * is put in the line of lag suggested by each information criterion

4.2.3.2 Test for multicollinearity

According to Gujarati (2003), in the case of multicollinearity, the OLS estimators are still BLUE (Best Linear Unbiased Estimate), but have large variances and covariances, making precise estimation difficult. Hence, the null hypothesis is more readily accepted, and the t-ratio of one or more coefficients tends to be statistically insignificant (Gujarati, 2003). The variance inflation factor (VIF) was used to test for multicollinearity in the ARDL model. Based on a rule of thumb, if the VIF of a variable exceeds 10, then the variable is considered highly collinear (Gujarati, 2003). As can be seen from table 4.5, the VIF of all variables are just over 1. Therefore, the model does not have the problem of multicollinearity.

Table 4.5. Result of variance inflation factor in ARDL model

Variable	VIF	1/VIF
dlfx		
L1.	1.12	0.896418
--.	1.12	0.896509
dlpratio		
L1.	1.07	0.932920
dlmongdp	1.07	0.936686
dlpratio	1.06	0.944858
dlmongdp		
L1.	1.05	0.951120
dlvnvol		
L1.	1.01	0.991027
Mean VIF	1.07	

4.2.3.3 Test for serial correlation

In the presence of serial correlation, the usual t and F test statistics are no longer valid, so we are likely to have misleading conclusions about statistical significance of the estimated coefficients (Gujarati, 2003). Again, a Breusch-Godfrey LM test is used to test for serial correlation of the residuals from the ARDL model. Table 4.6 describes the result of the test. All p-values are greater than 0.05. Thus, we cannot reject the null hypothesis of no autocorrelation, or that the residuals are not serially correlated at the 5% significance level. Therefore, the 1-month lag length makes the ARDL model dynamically complete and no other lags should be added into the model.

Table 4.6. Result of Breusch-Godfrey LM test for the residuals of ARDL model

lags(p)	chi2	df	Prob > chi2
1	1.238	1	0.2658
2	1.539	2	0.4633
3	1.573	3	0.6656
4	1.861	4	0.7613
5	2.225	5	0.8172
6	4.585	6	0.5981

4.2.3.4 Test for heteroskedasticity

According to Gujarati (2003), under both heteroskedasticity and autocorrelation, the OLS estimators may not be best linear unbiased estimators (BLUE). They are linear and unbiased, but not efficient relative to other linear and unbiased estimators (Gujarati, 2003). As a result, the t and F test statistics may not be valid (Gujarati, 2003).

Firstly, White's test was used to test for heteroskedasticity under the null hypothesis of homoskedasticity. In table 4.7, the p-value of White's test is higher than 0.05 but lower than 0.1. Thus, we cannot reject the null hypothesis at the significance levels of 1% and 5%, but not 10%. Then, to ensure that the model does not have a problem with heteroskedasticity, the Breusch-Pagan test for heteroskedasticity was implemented. The null hypothesis of the test is constant variance or homoskedasticity. As can be seen from the lower panel, the p-value of Breusch-Pagan test is greater than 0.1. So, we cannot reject the null hypothesis, or the error variance is constant at the 1%, 5% and 10% significance levels.

Table 4.7. Results of White's test and Breusch-Pagan test for the residuals of ARDL model

```
White's test for Ho: homoskedasticity
against Ha: unrestricted heteroskedasticity
chi2(35)      =     47.37
Prob > chi2   =    0.0791
Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	47.37	35	0.0791
Skewness	12.94	7	0.0737
Kurtosis	9.71	1	0.0018
Total	70.02	43	0.0057

```
Breusch-Pagan / Cook-Weisberg test for
heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of dlvnvol

         chi2(1)      =     0.02
         Prob > chi2  =   0.8749
```

To summary, OSL estimators of the 1-lag ARDL model (model 4.4) are BLUE, and t and F statistics are valid because diagnostic testing gave no evidence of multicollinearity, heteroskedasticity and serial correlation.

4.2.4 The relationship between Norwegian salmon imports to Vietnam and China

To investigate whether Vietnam's imports of Norwegian salmon are influenced by China's imports of Norwegian salmon after China's alleged sanction, a regression model of change in Vietnam's import volume on its own lags and lags of change in China's import volume was estimated using OLS. Additionally, the structural break was tested to see if it changes the estimated coefficients of the model, so that a conclusion on the role of the sanction can be made. The equation of the model is shown as follows:

$$dlvnvol = \gamma_0 + \sum_{i=1}^{p} \gamma_{1i} \times dlvnvol + \sum_{i=1}^{p} \gamma_{2i} \times dlcnvol + u_3 \tag{4.5}$$

where $\gamma_0, \gamma_{1i}, \gamma_{2i}$are unknown parameters, u_3 is the error term.

4.2.4.1 Model estimation

Firstly, the lag length (denoted as p in equation 4.5) selection procedure was implemented by using information criteria. The result in table 4.8 suggests that the 5-month lag length (p=5) should be chosen based on AIC. SBIC recommends a model with only 1 lag. While AIC might lead to overfitting and be more accurate with monthly data, SBIC has been seen to lead to underfitting in some cases of finite sample and work fine with quarterly data (Greene, 2003; Torres-Reyna, 2019). Furthermore, in this study, the impacts of more than one lag of China's import volume on Vietnam's import volume are of interest. So, the lag length of 5 months was selected.

Table 4.8. Criteria for lag length selection

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-146.75				.011215	1.18526	1.19656	1.21335
1	-135.287	22.927	4	0.000	.010568	1.12579	1.1597*	1.21006*
2	-133.087	4.3994	4	0.355	.01072	1.14013	1.19666	1.28059
3	-131.435	3.3037	4	0.508	.010923	1.15885	1.23798	1.35548
4	-126.887	9.0962	4	0.059	.010876	1.15448	1.25622	1.4073
5	-117.975	17.824*	4	0.001	.010459*	1.11534*	1.23969	1.42434
6	-115.467	5.0155	4	0.286	.010585	1.12723	1.27419	1.49241

Note: * is put in the line of lag suggested by each information criterion

Then, the model with five lags, as shown in equation 4.6, was estimated, followed by diagnostic tests for serial correlation and heteroskedasticity.

$$dlvnvol = \gamma_0 + \sum_{i=1}^{5} \gamma_{1i} \times dlvnvol + \sum_{i=1}^{5} \gamma_{2i} \times dlcnvol + u_3 \qquad (4.6)$$

The Breusch-Godfrey LM test provides no evidence of serial correlation of the residuals. In table 4.9, all p-values are much greater than 0.1. Therefore, we cannot reject the null hypothesis of no autocorrelation, or the residuals are not serially correlated at the significance levels of 10% and lower.

Table 4.9. Result of Breusch-Godfrey LM test for the residuals of model (4.6)

lags(p)	chi2	df	Prob > chi2
1	0.404	1	0.5251
2	4.222	2	0.1211
3	4.319	3	0.2290
4	4.429	4	0.3510
5	5.492	5	0.3589
6	6.698	6	0.3497

Table 4.10. Results of White's test and Breusch-Pagan test for the residuals of model (4.6)

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity
         chi2(65)      =     93.77
         Prob > chi2   =    0.0113
Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	93.77	65	0.0113
Skewness	32.43	10	0.0003
Kurtosis	8.28	1	0.0040
Total	134.47	76	0.0000

```
Breusch-Pagan / Cook-Weisberg test for
heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of dlvnvol

         chi2(1)       =      7.06
         Prob > chi2   =    0.0079
```

Table 4.10 shows the results of White's test and Breusch-Pagan test for heteroskedasticity. Because the p-value from White's test is higher than 0.01 but lower than 0.05, the second test was implemented. The p-value from Breusch-Pagan test is smaller than 0.01. Thus, we have to reject the null hypothesis of constant variance at the significance level of 1%. As a result, the problem with heteroskedasticity must be fixed by using robust standard errors. This can change the standard errors but the coefficients remain the same as before.

4.2.4.2 Test for structural break by the dummy variable

One of the applications of the dummy variable is to test for structural break. Structural changes may cause differences in the intercept or the slope or both (Gujarati, 2003). So, the first step is creating interaction terms between the dummy variable and lags of the dependent variable, and between the dummy variable and lags of the independent variable as well. The next step is running the regression for the following model:

$$\begin{aligned} dlvnvol = \delta_0 + \sum_{i=1}^{5} \delta_{1i} \times dlvnvol + \sum_{i=1}^{5} \delta_{2i} \times dlcnvol + \delta_3 \times sanc \\ + \sum_{i=1}^{5} \delta_{4i} \times sanc\_vn + \sum_{i=1}^{5} \delta_{5i} \times sanc\_cn + u_4 \end{aligned} \tag{4.7}$$

where $sanc\_vn = sanc \times dlvnvol, sanc\_cn = sanc \times dlcnvol$, $\delta_0, \delta_{1i}, \delta_{2i}, \delta_3, \delta_{4i}, \delta_{5i}$ are unknown parameters, u_4 is the error term.

Then, Breusch-Godfrey LM test and White's test were used to test for serial correlation and heteroskedasticity, respectively. To save the space, tables including the results of these tests hereafter are presented in the appendix. All p-values are greater than 0.05, so the residuals have constant variance and no serial correlation at the significance level of 5%. Finally, we test the joint significance of the interaction terms and the dummy variable itself. The null hypothesis is that $\delta_{2i} = \delta_3 = \delta_{4i} = 0$, or there is no structural break.

4.2.4.3 Wald test for structural break

After the estimation of model represented by equation (4.6), a Wald test was performed to test for the structural break under the assumption that the month of break is unknown. The test helps to determine whether and when there is a structural break occurring in the data (Stata, 2019). A single break divides the sample in two periods. Traditionally, a Chow test has been used to test for a structural break. The idea behind Chow test is to compare the residual sum of squares of sub-period regressions and whole-period regression. One of the assumptions of Chow test is that the error terms in two periods are homoskedastic, restricting the test performance (Gujarati, 2003). The Wald test, on the other hand, is robust to unknown forms of heteroskedasticity (Stata, 2019). The null hypothesis of Wald test is that there is no structural break.

4.2.4.4 Granger causality

Hamilton (2009) estimated a model of quarterly real GDP growth on 4 of its own lags and 4 lags of the net oil price increase to assess the impacts of oil price shocks on economic growth. Adopting Hamilton's technique, a change in Vietnam's salmon imports from Norway was regressed on 5 of its own lags and 5 lags of the change in China's salmon imports from Norway in two periods, before and after the sanction.

After a regression for each period, a Breusch-Godfrey LM test and White's test were performed to test for serial correlation and heteroskedasticity, respectively (the tables of results are in the appendix). For the regression after the sanction, the residuals are homoskedastic and not serially correlated at the significance levels of 1%. Meanwhile, for the regression of the period before the sanction, the residuals have no autocorrelation at any significance levels, but are heteroskedastic at the 10% significance level. The Breusch-Pagan test gave the results (as shown in the appendix) that variance of the error term is not constant at the 1% level. Thus, robust standard errors were used to correct for heteroskedasticity.

Then, the joint significance of 5 lags of change in China's import volume of Norwegian salmon was tested for each regression. The null hypothesis is that $\gamma_{21} = \gamma_{22} = \gamma_{23} = \gamma_{24} = \gamma_{25} = 0$, or that the lags of the change in China's salmon imports from Norway have no explanatory power on the change in Vietnam's salmon imports from Norway. If the null hypothesis is rejected, then the changes in China's salmon imports from Norway are said to Granger-cause the change in Vietnam's salmon imports from Norway (Torres-Reyna, 2019). Under the assumption that there are no re-exports or transshipment, legal or otherwise, there should be no relation between the volume that China imports from Norway and the volume that Vietnam imports from Norway. If there is a relationship, then it could suggest that as a result of China's alleged sanction on salmon from Norway, smuggling of salmon from Vietnam occurs in periods when China's import volume is low, and vice versa.

5 Results

5.1 Vietnam's import demand for Norwegian salmon

Vietnam's import demand function was estimated to test for the first hypothesis. The estimated coefficients express the effect of change in real income, price ratio and exchange rate on demand for imported salmon from Norway in Vietnam. The result of the 1-lag ARDL model regression is shown in table 5.1. "L1" is used to denote the first lag of variable, and "--" represents the current month. "l" means that the variable is in logarithmic scale, and "d" implies that variable is measured in first difference (the difference between this month and last month). The volume of Norwegian salmon imported by Vietnam is $vnvol$, real GDP by month is $mongdp$, the price ratio of Norwegian salmon to other exporters' salmon is $pratio$, and the exchange rate equal to NOK/VND is fx.

Table 5.1. Regression result of Vietnam's import demand function

dlvnvol	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dlvnvol						
L1.	-.2286839	.0611016	-3.74	0.000	-.3490281	-.1083397
dlmongdp						
--.	-.3539697	.6772988	-0.52	0.602	-1.687961	.9800215
L1.	-1.685417	.6721179	-2.51	0.013	-3.009204	-.3616301
dlpratio						
--.	-.104877	.2154687	-0.49	0.627	-.5292589	.3195048
L1.	-.246076	.216818	-1.13	0.257	-.6731155	.1809635
dlfx						
--.	.7127512	.8390411	0.85	0.396	-.9398038	2.365306
L1.	-.0221167	.8385552	-0.03	0.979	-1.673715	1.629481
_cons	.0327821	.0218076	1.50	0.134	-.0101697	.0757339

Number of obs	=	256
F(7, 248)	=	3.15
Prob > F	=	0.0033
R-squared	=	0.0817
Adj R-squared	=	0.0558
Root MSE	=	.3416

The coefficient of $dlvnvol_{t-1}$is -0.23 and statistically significant at the 1% level. Intuitively, if Vietnam's import volume of Norwegian salmon increases by 1 percent in this month, then it will decrease by 0.23 percent in the next month between July 1997 and December 2018.

While the coefficient of $dlmongdp_t$ is statistically insignificant, the coefficient of $dlmongdp_{t-1}$is equal to -1.69 and statistically significant at the level of 5%. This means that as real GDP grows by 1 percent in this month, Norwegian salmon imports to Vietnam falls by 1.69 percent, on average, in the next month during the period from July 1997 to December 2018. The relation is not consistent with theory discussed in chapter 3 because Norwegian salmon is considered as a superior good in the Vietnamese marketplace. A possible reason is that data on Vietnam's GDP might not be able to capture all domestic economic activities. Therefore, the change in real GDP is not sufficient to reflect change in the actual income of consumers. However, if the impact of real GDP growth is not misleading, it would cause Vietnam salmon imports from Norway to decrease for the whole study period as real GDP increased gradually with the monthly average growth rate of 0.54 percent. Thus, the change in real GDP cannot explain changes in Vietnam's import volume of Norwegian salmon in the period after China's alleged sanction.

Meanwhile, the coefficients of $dlpratio_t$, $dlpratio_{t-1}$, $dlfx_t$, and $dlfx_{t-1}$ are all statistically insignificant at the 5% level. In other words, changes in price ratio and exchange rate do not significantly influence change in Vietnam's import demand for salmon from Norway. The findings on price ratio and exchange rate are not in line with Xie, Myrland, & Kinnucan (2008), Xie, Kinnucan, & Myrland (2009) and Kinnucan & Myrland (2005). The absolute value of income elasticity might be consistent with the results of Xie et al., (2009) and Kinnucan & Myrland (2005), but the sign is not as expected by theory or as found by preceding empirical research. In summary, the estimation outcome of Vietnam's import demand function gave the statistical evidence suggesting that the first hypothesis is true. Hence, the sudden change in Vietnam's salmon trade pattern with Norway after China's alleged sanction do not seem to be driven by determining factors, including real GDP, price ratio and exchange rate, in general trade theory.

The limitation of data on the measurement of real income, real monthly GDP, might bring the appropriacy of the model into question. This can be a reason why the estimated parameter of the income variable is in contrast with expectations in its sign. Moreover, if smuggling occurs through Vietnam-China borders, then the behavior of smugglers should be an influencing factor of Vietnam's import demand for Norwegian salmon. For example, the wholesale price of Norwegian salmon in China or the difference between wholesale prices of Norwegian salmon in China's and Vietnam's marketplaces could be an explanatory variable in the model. An increase either in the absolute or relative domestic price might cause Vietnam's salmon import volume from Norway to increase. However, due to no access to data on wholesale prices of Norwegian salmon in the two markets, the model specification might be less appropriate.

5.2 Model of Vietnam's and China's import volume of Norwegian salmon

5.2.1 Model estimation

Table 5.2 describes the result of regression of the change in Vietnam's salmon imports from Norway on 5 of its own lags and 5 lags of the change in China's salmon imports from Norway with robust standard errors. "L1" to "L5" represent lag 1 to lag 5, respectively.

Table 5.2. Regression result of model (4.6)

dlvnvol	Coef.	Robust Std. Err.	t	P>|t|
dlvnvol				
L1.	-.2592587	.0789564	-3.28***	0.001
L2.	-.0351354	.0727954	-0.48	0.630
L3.	-.0510458	.0661617	-0.77	0.441
L4.	-.0508935	.0763866	-0.67	0.506
L5.	-.0129704	.0682679	-0.19	0.849
dlcnvol				
L1.	-.2156442	.097831	-2.20**	0.028
L2.	-.1363111	.0991406	-1.37	0.170
L3.	-.1844482	.0960952	-1.92*	0.056
L4.	-.1998054	.0675033	-2.96***	0.003
L5.	-.2833603	.0931173	-3.04***	0.003
_cons	.03469	.0210385	1.65	0.100

Number of obs	=	252
F(10, 241)	=	3.81
Prob > F	=	0.0001
R-squared	=	0.1569
Root MSE	=	.32784

Note: ***, ** and * are for 1%, 5% and 10% statistical significance, respectively

All coefficients have negative signs. While only $dlvnvol_{t-1}$ is statistically significant, three lags of change in China's salmon import volume from Norway, $dlcnvol_{t-1}$, $dlcnvol_{t-4}$ and $dlvnvol_{t-5}$, are statistically significant at either the 1% or the 5% significance level. The interpretation of the coefficients will be made after testing for a structural break because its presence changes the coefficients.

5.2.2 Structural break test – using dummy variable

In this test, the month of structural break must be pre-specified. Because China never officially declared its sanction against Norwegian salmon, we do not know exactly when the sanction started. Looking at data on Vietnam imports of Norwegian salmon, the volume suddenly increased by more than three times in March 2011. A similar effect of the sanction on China's imports happened earlier in January 2011. However, the volume of Norwegian salmon imported to Vietnam is the dependent variable. Thus, to explain it better, March 2011 should be chosen as the month of structural break. Table 5.3 reports the result of regression as the first step to test for structural break. The sanction variable, $sanc$, is a dummy, and $sanc\_vn$ and $sanc\_cn$ are interaction terms ($sanc\_vn$ and $sanc\_cn$ equal to $sanc$ multiplied by the change in Vietnam's and China's import volume of Norwegian salmon, respectively).

The joint significance of the dummy variable and interaction terms is the evidence of structural break occurring in March 2011. The F test yields the p-value of 0.0000 which is much lower than 0.01. So, we can reject the null hypothesis of no joint significance or that the coefficients of dummy variable and interaction terms all equal to zero at the significance level of 1%. In other words, the structural break of March 2011 actually changed the coefficients in the model presented in table 5.2.

Looking closer at the regression outcome in table 5.3, we can tell whether the structural break changed the intercept if the dummy variable itself is significant, or the slopes if one or more interaction terms are significant, or both. The dummy variable, $sanc$, is statistically insignificant at the 5% level. As a result, the structural break in March 2011 does not affect the intercept of the model. On the other hand, the coefficients of $sanc\_vn_{t-1}$ and $sanc\_vn_{t-3}$ are statistically significant at the 1% level. Thus, the presence of the structural break changes the coefficients of $dlvnvol_{t-1}$ and $dlvnvol_{t-3}$. Similarly, the coefficient of $sanc\_cn_{t-2}$ is statistically significant at 5% significance level. Therefore, the structural break also changes the coefficient of $dlcnvol_{t-2}$. To summarize, the structural break in March

2011 leads to parameter instability through significantly affecting slope of the model. This suggests that the relation between Vietnam's and China's imports of Norwegian salmon has changed after China allegedly imposed the sanction against salmon from Norway.

Table 5.3. Regression result of model (4.7)

dlvnvol	Coef.	Std. Err.	t	P>|t|
dlvnvol				
L1.	-.6669605	.0884072	-7.54***	0.000
L2.	-.2993197	.1032298	-2.90***	0.004
L3.	-.2925527	.1032228	-2.83***	0.005
L4.	-.2968916	.1001726	-2.96***	0.003
L5.	-.122343	.0849098	-1.44	0.151
dlcnvol				
L1.	-.2409113	.1032345	-2.33**	0.020
L2.	-.2422873	.1060882	-2.28**	0.023
L3.	-.0878139	.1126258	-0.78	0.436
L4.	-.0720762	.1094345	-0.66	0.511
L5.	-.3273038	.1100557	-2.97***	0.003
sanc	-.0589275	.0408134	-1.44	0.150
sanc_vn				
L1.	.8280269	.1279619	6.47***	0.000
L2.	.1395199	.1402174	1.00	0.321
L3.	.3609565	.1393944	2.59***	0.010
L4.	.2392723	.1353516	1.77*	0.078
L5.	.1147216	.123671	0.93	0.355
sanc_cn				
L1.	.0964614	.1331428	0.72	0.469
L2.	.2749719	.1319555	2.08**	0.038
L3.	-.0592946	.1378091	-0.43	0.667
L4.	-.0946769	.1364408	-0.69	0.488
L5.	.1889311	.1357183	1.39	0.165
_cons	.0663071	.0251089	2.64	0.009

Number of obs	=	252
F(21, 230)	=	5.38
Prob > F	=	0.0000
R-squared	=	0.3296
Adj R-squared	=	0.2684
Root MSE	=	.29926

Note: ***, ** and * are for 1%, 5% and 10% statistical significance, respectively

5.2.3 Structural break test – using Wald test

A Wald test was performed to test for unknown structural break under the null hypothesis of no structural break. The purposes of running the test are to ensure the influence of the structural break on the model regression and to check for the choice of the month when the dummy variable starts to take a value of 1. The p-value of 0.0000 is much smaller than 0.01. Thus, we can reject the null hypothesis of no structural break. In other words, there is a structural break when a time series abruptly changes (Stata, 2019) and its significance level is 1%.

Moreover, Wald test detects the month of break in April 2011, one month after the chosen break. Two tests can give different results, but the difference is small. So, for further analysis, the structural break of March 2011 can be used as the month when the sanction came into effect from Vietnam's perspective.

5.2.4 Results of Granger causality

The structural break, March 2011, divides the study period into two sub-periods: July 1997 – February 2011 (before the sanction) and March 2011 – December 2018 (after the sanction). The model (4.6) was re-estimated in each sub-period. The results given by the two regressions are reported in tables 5.4.

The R-squares yielded by the regressions before and after the sanction are 0.3891 and 0.2066, respectively. This means that 38.91% and 20.66% of the change in Vietnam's salmon imports from Norway before and after the sanction, respectively, can be explained by the independent variables in the two regressions. The coefficients are different in the two periods. The coefficients of 4 of the lags of $dlvnvol$ are statistically significant at the 5% level in the first period, but not in the second period. On the other hand, coefficients of lag 1, 3 and 5 of $dlcnvol$ are statistically significant at the 5% level in the second period, but all coefficients of lags of $dlcnvol$ are statistically insignificant at the 5% level in the first period.

In the period before the sanction, the change in the volume of Norwegian salmon imported by Vietnam in this month was negatively affected by its values in the four previous months, and not significantly influenced by lags of the change in China's import volume of salmon from Norway. This implies that before March 2011, Vietnam's and China's salmon markets are separate markets. However, after the sanction, the change in Vietnam's salmon imports from Norway was not significantly affected by its own lags, but negatively driven by changes in China's salmon imports from Norway in the last month, and in the third and fifth previous months.

Table 5.4. Results of regressions of the two sub-periods

	Sub-period from July 1997 to February 2011				Sub-period from March 2011 to December 2018			
dlvnvol	Coef.	Robust Std. Err.	t	P>|t|	Coef.	Std. Err.	t	P>|t|
dlvnvol								
L1.	-.6513041	.0919515	-7.08	0.000	.1221505	.1046966	1.17	0.247
L2.	-.2935087	.1223455	-2.40	0.018	-.1719621	.1061352	-1.62	0.109
L3.	-.2937372	.1215125	-2.42	0.017	.0959531	.1040548	0.92	0.359
L4.	-.29693	.1075912	-2.76	0.007	-.0635869	.1060843	-0.60	0.551
L5.	-.1396402	.0852811	-1.64	0.104	.0120975	.1041878	0.12	0.908
dlcnvol								
L1.	-.0712267	.1289117	-0.55	0.581	-.2498709	.0938246	-2.66	0.009
L2.	.0831044	.1392783	0.60	0.552	-.126026	.0876046	-1.44	0.154
L3.	.2047812	.1463222	1.40	0.164	-.2134134	.0884687	-2.41	0.018
L4.	.1287815	.1206876	1.07	0.288	-.1743138	.0909482	-1.92	0.059
L5.	-.2295112	.1254947	-1.83	0.069	-.2013758	.091338	-2.20	0.030
_cons	.0546263	.0231695	2.36	0.020	.0247472	.0365242	0.68	0.500
	Number of obs = 158 F(10, 147) = 9.31 Prob > F = 0.0000 R-squared = 0.3891 Root MSE = .27159				Number of obs = 94 F(10, 83) = 2.16 Prob > F = 0.0283 R-squared = 0.2066 Adj R-squared = 0.1110 Root MSE = .35215			

This evidence suggests that as a result of sanction, there has been a statistical relationship between quantities of salmon imported from Norway to Vietnam and China, leading to a link between Vietnam's and China's geographically autonomous salmon markets. To strengthen the link, tests for Granger causality were implemented after each regression.

Table 5.5 shows the results of F test for Granger causality in the two sub-periods, i.e. before and after the sanction. For the pre-sanction period, the p-value is greater than 0.1. Thus, we cannot reject the null hypothesis of no joint significance (no Granger causality) at the 10% level of significance. In other words, we are confident that prior to the sanction, a change in China's import volume of Norwegian salmon did not "Granger-cause" a change in Vietnam's import volume of Norwegian salmon. For the period after the sanction, the F test for Granger causality yielded a different result. The p-value is lower than 0.01. Therefore, we can reject the null hypothesis of no Granger causality at the 1% significance level. Intuitively, as the sanction was put in place, the change in Norwegian salmon imports into China did "Granger-cause" the change in Norwegian salmon imports into Vietnam.

Table 5.5. Result of test for Granger causality in two sub-periods

before the sanction	after the sanction
(1) L.dlcnvol = 0	(1) L.dlcnvol = 0
(2) L2.dlcnvol = 0	(2) L2.dlcnvol = 0
(3) L3.dlcnvol = 0	(3) L3.dlcnvol = 0
(4) L4.dlcnvol = 0	(4) L4.dlcnvol = 0
(5) L5.dlcnvol = 0	(5) L5.dlcnvol = 0
F(5, 147) = 1.47	F(5, 83) = 3.39
Prob > F = 0.2014	Prob > F = 0.0077

To summarize, regressions and tests performed in section 5.2 offer supporting evidence that Vietnam's sudden increase in imports of Norwegian salmon is related to China's alleged sanction on Norwegian salmon and that an inverse relation exists between China's imports and Vietnam's imports. Due to the sanction, the inverse relation between Vietnam's and China's import volumes of Norwegian salmon has been established. To specify, after March 2011, a statistically significant decrease in imports of Norwegian salmon into China caused an increase in imports of Norwegian salmon into Vietnam with time lag of 1, 3 and 5 months. It is reasonable that Vietnam's salmon market needs some time to react to what happened in China's salmon market as a consequence of the sanction. Vietnam's strange behavior of importing salmon from Norway cannot be explained by trade theory where Vietnam's specific market situation determines import volume. A possible explanation is China's alleged sanction and its effect on China's imports of Norwegian salmon. The outcome of testing the second hypothesis provides statistical evidence supporting the explanation. After March 2011, a large share of Norwegian salmon imported to Vietnam might not be consumed in domestic market, but delivered to China's market by stakeholders. This is consistent with the argument made by Chen & Garcia (2016). It is not possible to know the exact share, but let us suppose that Vietnam's true demand for Norwegian salmon in March 2011 was as the same as the average imports in 2010 (approximately 49 tons). If so, then 62.2 percent of Vietnam's import volume of Norwegian salmon was re-exported or transshipped legally or illegally to China in March 2011. The share might increase after that because from April 2011, Vietnam's imports of Norwegian salmon fluctuated and but never fell below the level of March 2011.

The link between Vietnam's and China's imports of Norwegian salmon after the sanction suggests the connection of the two markets. Vietnam and China are neighboring countries, facilitating sanction-bursting efforts through porous borders. The Chinese consumers' preference for Norwegian salmon could explain the motivation for these efforts. There are no official reports on re-exports or legal transshipment of salmon into China via Vietnam. Thus, if sanction-bursting happens, it is illegal or smuggled. Chen & Garcia (2016) argued two main reasons why smuggling has been continued for a long time. First, since China's sanction is subtle, China may not be able to officially cooperate with Vietnam to prevent smuggling. Second, the objective of China's sanction is to signal China's displeasure with the Nobel Peace Prize for 2010. Therefore, China had not bothered to penalize smuggling until a salmon smuggling group was discovered in April 2018 (Chen & Garcia, 2016; Garza, 2018). Without government intervention, if markets are integrated, the flow of Norwegian salmon would be driven by consumers' demand and smugglers' operation, dampening the trade effect of the sanction (Vinuya, 2007; Goletti, Ahmed, & Farid, 1995).

Smuggling is illegal and not officially reported, leading to some adverse consequences besides neutralizing the influence of sanction on trade. Firstly, the Chinese government would lose a large amount of tax revenue. Smugglers do not pay import tax, and Chinese consumers can avoid value added tax for their consumption of Norwegian salmon. However, the Vietnamese government collects the import tariff because Norwegian salmon is imported legally into Vietnam. Secondly, smuggling distorts trade data. For example, it makes the use of the official data on direct imports from Norway to Vietnam and China unreliable (Chen & Garcia, 2016) because import data fail to reflect the actual demand for Norwegian salmon in Vietnam and China.

The sanction might cause a price shock in China's salmon markets. Based on McNew (1996), the price shock would be transmitted between Vietnam's and China's salmon markets through the attempts of private sector agents to burst the sanction. For instance, when China's salmon imports from Norway are restricted by the sanction, there is a lack of supply of Norwegian salmon in China's market. This might lead to an increase in price of Norwegian salmon in China. Because there are no data on domestic prices of Norwegian salmon in China and Vietnam, I speculate that there is a difference between these prices that motivate stakeholders to smuggle Norwegian salmon into China from Vietnam. In theory, smuggling would bring Norwegian salmon's prices in Vietnam and China to converge because the flow of salmon from Vietnam to China gradually lowers China's domestic price and raises Vietnam's domestic price (Vinuya, 2007; Goletti, Ahmed, & Farid, 1995).

In reality, a considerable change in price of Norwegian salmon might not happen in Vietnam. The plausibility of the first hypothesis implies that Vietnam's salmon imports from Norway were likely to surpass demand for salmon in Vietnam's domestic market. Thus, if imported Norwegian salmon flowed from Vietnam to China, there would be no scarcity of Norwegian salmon in Vietnam's market, resulting in no dramatic increase in Norwegian salmon's price in Vietnam. As a consequence, price convergence in Vietnam's and China's salmon markets might take longer time to happen, generating more opportunities for stakeholders to gain profits from smuggling. Meanwhile, thanks to sanction-bursting strategies, Chinese consumers suffer less from an increase in domestic price of Norwegian salmon imported to China under stricter border controls (Asche et al., 2011). However, Chinese consumers would undergo quality degradation if Norwegian salmon is smuggled by inadequate transportation facilities (Chen & Garcia, 2016). Smuggling in summer is highly likely to result in lower quality of salmon. Therefore, Chinese consumers would be better off buying smuggled Norwegian salmon in winter. Nevertheless, the monthly data on Vietnam's import volume of Norwegian salmon shows no seasonality, but fluctuates all year round. This raises a question about the Chinese consumers' perception of quality deterioration. It would be possible that they cannot distinguish lower-quality salmon, and continue to buy smuggled Norwegian salmon as it is cheaper than legally-imported Norwegian salmon. If the loss due to quality degradation is greater than the benefit of lower price, then Chinese consumers would be the ultimate losers.

The flow of Norwegian salmon from Vietnam to China implies price convergence in the long run. Therefore, the statistically inverse relationship between changes in Vietnam's and China's import volume of Norwegian salmon after the sanction suggests some degree of market integration. Market integration in the form of price convergence happens under assumptions proposed by Jacks (2000) and Li, Joyeux, & Ripple (2010). In the case of Vietnam and China, it is hard to know if Vietnam's and China's salmon markets are competitive. However, other assumptions might hold. For example, there are stakeholders who admitted or uncovered to engage in smuggling (Chen & Garcia, 2016; Harkell, 2018). In addition, Vietnam's and China's markets have a long history of connection through borders. More importantly, smuggling is free of tariffs, and Vietnam and China seemed not to take effective actions to control their shared borders (Chen & Garcia, 2016). Nevertheless, there is reason to expect prices of Norwegian salmon in Vietnam's and China's markets to converge up to the level of transportation and/or transaction costs in the long term as these costs cannot be neglected in real world. Moreover, if smuggling is successful, there should be a premium paid in China for the smugglers to take the risk.

6 Conclusions

The study is an attempt to provide insights into the interaction between Vietnam's and China's salmon markets as a consequence of China's alleged sanction against Norwegian salmon. Through the use of econometric methods, two regression models are constructed to test for two hypotheses using monthly data from July 1997 to December 2018. The first model is an ARDL model that estimates Vietnam's import demand of Norwegian salmon. The change in Vietnam's import volume of Norwegian salmon is the dependent variable, and changes in real GDP, relative price ratio and the exchange rate are independent variables. In the second model, the change in Vietnam's imports of salmon from Norway was regressed on 5 of its own lags and 5 lags of the change in China's imports of salmon from Norway. Normally, there should not be any relation between Vietnam's imports of Norwegian salmon and China's imports of the same, unless the markets were somehow integrated. However, there are no reported re-exports or legal transshipment of Norwegian salmon between the two countries. After the regression, the structural break was tested using a sanction dummy and a Wald test. Finally, the second model was estimated in two sub-periods, before and after the sanction, to see how the coefficients and Granger causality changed due to the break.

The estimation results of model 1 indicate that change in the quantity of Norwegian salmon imported into Vietnam in the current month was negatively affected by change in quantity of Norwegian salmon imported into Vietnam and change in real GDP in the previous month by a magnitude of 0.23 and 1.69, respectively. On the other hand, changes in the price ratio and exchange rate had no statistical effects on Vietnam salmon imports from Norway. In other words, during the study period, Vietnam's import demand for Norwegian salmon was negatively elastic with respect to real income, but not influenced by the movements in the relative price ratio and exchange rate. Although being inconsistent with theory and empirical research, these findings statistically support the first hypothesis that sudden changes in Vietnam's trade pattern of Norwegian salmon after China's alleged sanction cannot seem to be explained by the determining factors of import demand function as per trade theory.

The strange behavior of Vietnam on its import of Norwegian salmon occurred from March 2011. Therefore, the month can be considered as when the sanction started to affect Vietnam's salmon imports from Norway, so the dummy variable takes the value of 1 from this month. The outcome of the structural break tests confirms that March 2011 is the structural break that made the coefficients of model 2's regression instable. Thus, the study period is divided into two sub-periods, i.e. before and after the sanction. For instance, the coefficients of lags of change in quantity of salmon imported from Norway into Vietnam are statistically significant before the sanction, but statistically insignificant after the sanction. In contrast, lags of change in volume of Norwegian salmon imported by China have negatively significant effects on change in volume of Norwegian salmon imported by Vietnam after the sanction, but not before the sanction. The Granger causality test also suggest that lags of change in China imports of Norwegian salmon "Granger-cause" change in Vietnam imports of Norwegian salmon only after the sanction. These findings prove the plausibility of the second hypothesis that there is a statistical relationship between an increase (decrease) in Vietnam's import quantity of Norwegian salmon and a decrease (increase) in China's as a result of the sanction.

This statistical link suggests the flow of Norwegian salmon into China via Vietnam. Since there are no re-exports or legal transshipment officially reported, illegal delivery, or smuggling, is suspected to bring Norwegian salmon from Vietnam to China. Chen & Garcia (2016) conducted field interviews with stakeholders who admitted to smuggling Norwegian salmon into China from Vietnam to circumvent China's discriminatory practices against salmon from Norway. Newspaper articles also revealed smuggling as an effort to burst the sanction (Harkell, 2018; Seaman & Harkell, 2018; Garza, 2018). The prices of landed Norwegian salmon do not differ substantially between in Vietnam and in China (Norwegian Seafood Council, 2019). Through the Granger causality analysis, there is a strong reason to suggest that when the sanction was allegedly imposed, it might lead to a difference between wholesale prices of Norwegian salmon in Vietnam's and China's markets, motivating traders to earn profits from smuggling Norwegian salmon into China via Vietnam. If Norwegian salmon was smuggled to China, the price of Norwegian salmon would gradually decrease in China's markets. Thus, Chinese consumers may suffer less from the price adjustment, compared to a scenario of no smuggling. However, they may experience the quality deterioration of smuggled salmon, especially in summer. The data on the monthly imports of Norwegian salmon by Vietnam indicates no seasonality. A possible explanation is that without any perception of lower quality of salmon, Chinese consumers might have consumed salmon smuggled from Vietnam throughout the year. Therefore, they would be hurt if the benefit from better price cannot compensate the loss from lower quality.

In Vietnam's market, Norwegian salmon's price is not expected to increase because Vietnam's imports of salmon from Norway have exceeded the actual domestic demand. This would make the prices of Norwegian salmon in Vietnam's and China's markets take longer time to converge, leaving more rooms for smuggling. In the long run, price convergence would happen up to the point that the price of Norwegian salmon in China equals to the price of Norwegian salmon in Vietnam plus transportation and/or transaction costs. Therefore, the inversely statistical relation between change in Vietnam's import volume of Norwegian salmon and change in China's coinciding the period after China's alleged sanction implies that to some extent, Vietnam's salmon market has become integrated with China's as a result of the sanction.

Markets are not supposed to be integrated through smuggling in theory. In the case of Vietnam and China, the statistical evidence of this study combined with the finding of previous research and information on newspapers suggest the role of smuggling in connecting the two markets after the sanction. Smuggling dampens the trade effect of the sanction, distorts trade data and causes losses in tax revenue. However, why has it still happened? The Chinese government itself was not willing to penalize individuals involving in smuggling, and did not effectively cooperate with the Vietnamese government to tighten border controls long after the sanction (Chen & Garcia, 2016). This is an important condition for market integration of Vietnam's and China's salmon markets to take place as a consequence of China's alleged sanction against Norwegian salmon. Thus, if Vietnam and China collaborate to strictly control their shared borders, market integration would break down.

6.1 Limitations of the study

Firstly, because of no monthly data on GDP, Vietnam's monthly real GDP was calculated using annual nominal GDP and monthly CPI. Hence, the data are inaccurate. Moreover, the definition of annual GDP might not capture all values of economic activities, for example, formal and informal. So, changes in monthly real GDP do not appropriately reflect changes in real income of Vietnamese consumers, leading to the reliability of $dlmongdp$'s coefficient to be questionable.

Secondly, the study lacks field interviews with Vietnamese traders to corroborate whether those involved in the trade have noticed or acknowledged the practices of smuggling Norwegian salmon from Vietnam to China. If conducted, interview results would give practical evidence to strengthen the case of smuggling that flow Norwegian salmon into China via Vietnam. The study also lack the wholesale or retail prices of Norwegian salmon in China and Vietnam, which can help to define the rents that motivate stakeholders to engage in smuggling and to more appropriately estimate the Vietnam's import demand function for Norwegian salmon.

Thirdly, as China's sanction on Norwegian salmon is subtle, it has never been formally declared started or ended. Thus, detailed records on whether China's custom practices and border measures have changed after China-Norway full normalization would help to clarify whether the salmon trade between China and Norway is back to normal or whether import restrictions are still in place. Due to a lack of these records, the study is limited in the confidence of its final conclusion.

6.2 Suggestions for further research

A study on the influence of China's alleged sanction on Norway salmon exports should be called for. Because of losing its market share in China, has Norway found other markets for its salmon exports? Also, the effect of the sanction on the world price of Norwegian salmon is another area for research.

In the future, if data on domestic prices of Norwegian salmon in Vietnam and China's markets are available for the periods before and after the sanction, research on price convergence is another avenue of study. It helps to estimate the magnitude of price differentials that could have motivated smuggling.

If there are reports on whether China has lifted non-tariff barriers on Norwegian salmon after China-Norway full normalization, a study on the consumption of salmon from Norway in China's marketplace would be of interest. Has Norway come back to the position of market leader after the sanction ended, or has Chinese consumers been gradually accustomed with salmon from other exporters?

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Appendix A. Result of Breusch-Godfrey LM test in the model including dummy variable and interaction terms

lags(p)	chi2	df	Prob > chi2
1	0.003	1	0.9534
2	2.637	2	0.2676
3	2.895	3	0.4082
4	4.752	4	0.3137
5	4.997	5	0.4162
6	12.051	6	0.0608

H0: no serial correlation

Appendix B. Result of White's test in the model including dummy variable and interaction terms

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity
         chi2(136)    =    139.62
         Prob > chi2  =    0.3983
Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	139.62	136	0.3983
Skewness	16.23	21	0.7567
Kurtosis	2.80	1	0.0942
Total	158.64	158	0.4706

Appendix C. Result of Breusch-Godfrey LM test for the residuals of regression before the sanction

lags(p)	chi2	df	Prob > chi2
1	0.229	1	0.6322
2	2.359	2	0.3074
3	2.495	3	0.4762
4	2.506	4	0.6436
5	2.751	5	0.7383
6	3.465	6	0.7487

H0: no serial correlation

Appendix D. Result of White's test for the residuals of regression before the sanction

```
White's test for Ho: homoskedasticity
against Ha: unrestricted heteroskedasticity
chi2(65)     =     80.69
Prob > chi2  =    0.0908
Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	80.69	65	0.0908
Skewness	13.58	10	0.1932
Kurtosis	9.35	1	0.0022
Total	103.61	76	0.0194

Appendix E. Result of Breusch-Pagan test for the residuals of regression before the sanction

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of dlvnvol

         chi2(1)      =     8.66
         Prob > chi2  =   0.0032
```

Appendix F. Result of Breusch-Godfrey LM test for the residuals of regression after the sanction

lags(p)	chi2	df	Prob > chi2
1	1.294	1	0.2553
2	1.949	2	0.3773
3	2.601	3	0.4574
4	3.361	4	0.4994
5	3.363	5	0.6442
6	8.823	6	0.1838

H0: no serial correlation

Appendix G. Result of White's test for the residuals of regression after the sanction

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity
         chi2(65)     =     52.66
         Prob > chi2  =    0.8644
Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	52.66	65	0.8644
Skewness	7.63	10	0.6652
Kurtosis	1.68	1	0.1945
Total	61.97	76	0.8774

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