Impact of US-China Trade Friction
—An Overview Based on Value Added Trade Statistics—

By Yuji Miura
Advanced Senior Economist
Economics Department
Japan Research Institute

Summary

1.   By using value added trade statistics to avoid the "double counting" issue, we can obtain an accurate picture of global value chains (GVCs), which have become complicated due to fragmentation on a global scale. At the end of 2018, the Organization for Economic Co-operation and Development (OECD) updated its Trade in Value Added (TiVA) statistics and published data for the period from 2005 to 2015.

2.   Three insights have emerged from the TiVA data. First, bilateral trade figures based on value added are different from gross-based figures. Second, exported goods can incorporate value added produced in countries other than the exporting country. Third, exports include substantial value added produced by service industries.

3.   According to the International Monetary Fund (IMF), which has estimated the potential impact of the US-China trade war under several scenarios, the impact on both China and Japan will be negligible unless the United States raises the tariff rate on Chinese goods worth $200 billion to 25%. Tariff increases will start to have a major impact on the Chinese economy at the stage when they are imposed on all products imported from China.

4.   The domestically produced value included in goods exported to the United States by China is equivalent to 3.6% of China's GDP, and 1.2% of U.S. GDP. Continuing tit-for-tat tariff increases could trigger a trade diversion effect, resulting in a loss of value added exports equivalent to 3.2% of China's GDP and 1.1% of U.S. GDP.

5.   China's value added exports to the U.S. are driven by manufacturing. However, electrical, electronic, and textile products, which are China's main exports to the United States, do not constitute a large share of the 5,137 items worth $200 billion on which the Office of the United States Trade Representative (USTR) has imposed an additional 10% tariff. We can reasonably conclude, therefore, that the current decline in Japan's exports to China is primarily due to sluggish domestic demand in China, rather than the effects of the tariff increases.

6.   If the U.S. imposes tariffs on all of its Chinese imports, goods exported to the United States via China from neighboring Asian countries and regions will also be left in limbo. Such exports make up 1.3% of GDP in the case of Taiwan, 0.6% for South Korea and Malaysia, 0.5% for Singapore, 0.4% for Thailand and the Philippines, 0.3% for Vietnam, 0.2% for Japan. Global value chains in East Asia center on the electrical and electronics industries, and these industries would bear the brunt of tariff hikes.

7.   If trade friction between the U.S. and China continues to escalate, neighboring Asian countries and regions will be seriously impacted by the resulting slowdown of the Chinese economy. Value added exports to China account for 13.4% of Taiwan's GDP. The figures for other Asian countries are 7.5% for South Korea, 5.2% for ASEAN, and 2.9% for Japan. However, a major slowdown in the Chinese economy is unlikely to occur in 2019 thanks to economic stimulus measures.

Introduction

The US-China trade talks continue to founder. A US-China summit originally planned for March 2019 was postponed until late April[1], and then a few days later the parties announced that the talks were likely to be delayed until June[2]. In addition, President Trump indicated that the retaliatory tariffs would remain in place even if an agreement is reached[3], indicating that the United States is not interested in reaching an amicable settlement through summit talks. Even if the summit takes place, it will only produce a stop-gap settlement, and we should assume that the trade friction will continue to smolder.

Past experience of trade friction between Japan and the U.S. indicates that US-China trade friction is likely to be a long-term phenomenon. Japan-US trade friction did not end because of a reduction in Japan's trade surplus with the U.S., but rather dissipated like mist after the bursting of Japan's economic bubble. China is becoming a serious threat to the United States in such areas as the telecommunications standards on which 5G telecommunications will be based, and semiconductors for smartphones. There is a strong possibility that China will overtake the United States in terms of GDP by around 2030. U.S. wariness toward China is likely to increase rather than decrease.

US-China trade friction is certain to have an adverse impact on the world economy. Every day, the media carry reports about the direction of the US-China talks and how the effects of trade friction are being manifested. However, it is not easy to predict the outlook for US-China trade friction. Nor is it easy to identify which industries in which countries will be impacted by tariff increases in a world economy based on highly developed global value chains (GVCs).

We cannot readily determine the extent to which the tariff increases will affect China's exports to the U.S. simply by analyzing international balance of payments data and customs-clearance statistics. Because goods exported from China to the United States contain substantial amounts of value added produced in other Asian countries, including Japan, we tend to overestimate the impact of U.S. tariff hikes on China and underestimate the effects on China's Asian neighbors. To ascertain the extent to which the tariff increases are impacting on different countries and regions, we need value added data showing which countries and industries produced the exports.

This article was written to answer these questions using Trade in Value Added (TiVA) statistics maintained by the Organization for Economic Co-operation and Development (OECD). Part 1 provides a simple outline of the structure and characteristics of TiVA statistics. Part 2 analyzes the impact of US-China trade friction on the United States and China. Part 3 examines the impact of the US-China trade friction on Asian countries and regions neighboring China, including Japan, in terms of value added exports as percentages of GDP, and identifies industries that are likely to be affected.

1. Mechanisms and Characteristics of Value Added Trade Statistics

In this section we will look at the differences between value added trade statistics and trade statistics in general use. We will also consider what can be learned from value added statistics.

(1) Value Added Trade Statistics as a Solution to the "Double Counting" Problem

Value added statistics identify the origin of the value added of goods and services traded between countries. Such statistics were not needed in the era of classical trade, as described in international economics textbooks, when goods such as wine and woolen textiles were traded bilaterally. The value added of wine and woolen textiles was entirely produced within the exporting countries, so the traded value of these items was equal to their
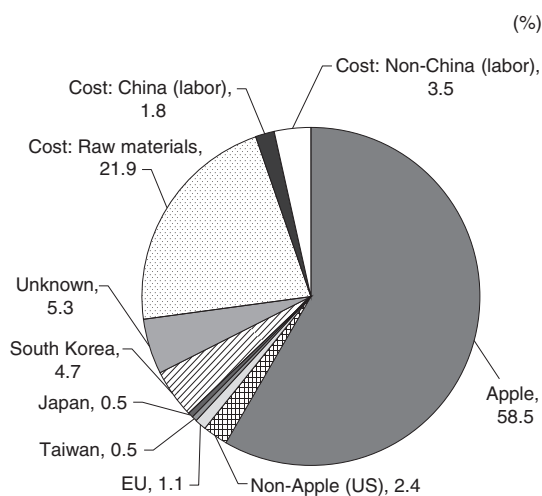
value added.

However, companies today are shifting some of their operations overseas in order to reduce the cost of labor, raw materials and other imports, while also improving production efficiency. This trend has emerged in response to falling cost of offshoring, thanks to the development of international logistics and communications systems. In fact, most of the manufactured goods sold in developed economies are produced by multinational companies in developing economies. Evidence of this can be found in the labels of these products. In the case of apparel, the "made in" label indicates the country where sewing processes are carried out, while PCs and smartphones are labeled as made in the countries where they are assembled.

Unlike wine and woolen textiles, modern manufactured goods require numerous raw materials and parts, with the result that manufacturing processes are intricately subdivided. This means that a significant portion of the value added built into final products is imported from countries other than the country of production. Apple products are often cited as examples of this kind of global value chain mechanism. The Apple iPhone is labeled as "made in China" because it is exported worldwide after final assembly in China. However, China's contribution to the value added of the iPhone is limited to the labor used in the final assembly process, which amounts to only 1.8% overall (Fig.1). However, Fig.1 is based on data from almost ten years ago, and there is a strong possibility that China's share of the value added of the iPhone has risen substantially, as explained below.

In any event, we can conclude that value added trade statistics are well-suited to the task of explaining the increasingly complex GVCs that form due to fragmentation on a global scale. Instead of customs clearance statistics, which are generally used as the basis for trade statistics, value added trade statistics are based on input-output tables. Input-output tables are statistical tables designed to reflect the circulation structure of national economies by showing inter-industry transactions within a country over a specific period of time on

Fig. 1 Value Added Structure of the iPhone (2010)

(%)

Cost: China (labor), 1.8
Cost: Non-China (labor), 3.5
Cost: Raw materials, 21.9
Unknown, 5.3
South Korea, 4.7
Japan, 0.5
Taiwan, 0.5
EU, 1.1
Non-Apple (US), 2.4
Apple, 58.5

Source: Compiled by JRI, using Kramer, Liden, Dedrick [2011]

a single matrix. By linking these input-output tables together on a global scale, value added trade statistics allow us to understand the flow of value added through to the production the final goods (Fig.2).

Fig.2 provides a simple overview of the mechanisms of value added trade statistics. As shown in the diagram, three countries, A, B and C, are involved in the manufacture of products that will be consumed in country D. Country A produces raw materials for the final products and exports the equivalent of two units of value added to Country B. Country B raises the value added to 26 units by processing these raw materials. It then exports this value added to Country C, where assembly processes increase the value added units to 72. This value added is then exported to Country D, which is the country of final demand. On a transaction basis (gross), two units are exported from Country A to Country B, 26 units from Country B to Country C, and 72 units from Country C to Country D, resulting in global exports of 100 units.

On a value added basis, however, the goods exported from Country B to Country C include the two units of value added produced in Country A, while the 72 units of value added exported from

Fig. 2 Mechanism of Value Added Trade Statistics
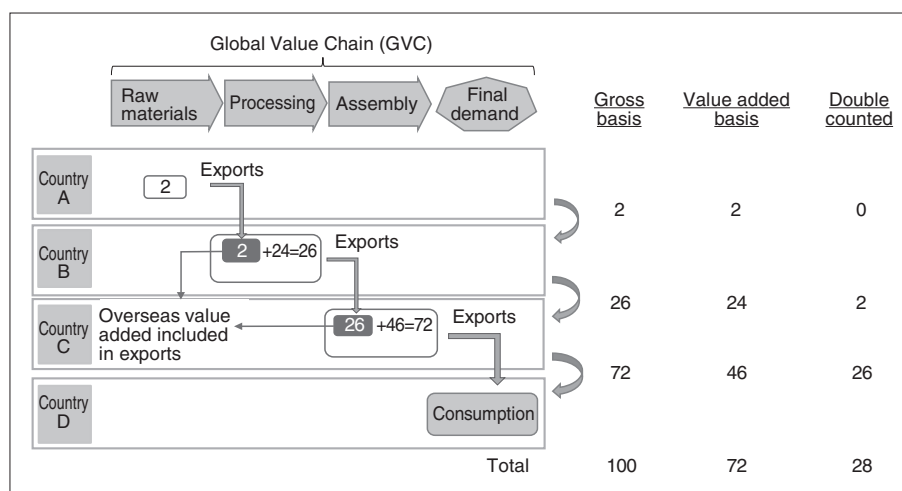
Source: Compiled by JRI, using Javorsek and Camacho [2015]

Country C to Country D also incorporate the two units of value added exported by Country A to Country B, as well as the 24 units of value added produced by Country B and exported to Country C. If we exclude this double counting factor, the value added of goods exported from Country A to Country B remains unchanged at two units, while that of goods exported from Country B to Country C becomes 24 (26-2), and that of goods exported from country C to Country D becomes 46 (72-(2+24)), which means that the total amount of value added included in the global exports will be 72 units (2+24+46). This ability to eliminate double counting is the most important feature of value added trade statistics.

The analysis in Fig.2 was possible thanks to the TiVA data maintained by the OECD. In December 2018, the TiVA data for the 2005-2015 period was completely updated, dramatically improving its utility. The TiVA statistics not only provide individual entries for 69 countries and regions, including Japan and other major economies such as the U.S., the EU, China, South Korea, Taiwan and ASEAN (Association of Southeast Asian Nations), but can also be used to extract aggregated data for political and economic frameworks, such as APEC, ASEAN, the EU and G20, or by geographical region, such as East Asia, North America, Europe or Latin America.

While Fig.2 does not refer to industries, the TiVA statistics include 36 industry classifications based on the International Standard Industrial Classification of All Economic Activities (ISIC). ISIC divides industries into seven major categories: (1) agriculture, forestry and fishing, (2) mining and quarrying, (3) manufacturing, (4) utilities, (5) construction, (6) administrative and support service activities, and (7) public administration, education and medical services. These seven major categories are further broken down into medium and minor categories. For example, the manufacturing industry category is divided up into nine medium categories, which are (1) foods and beverages, (2) textiles, (3) wood, paper, and printing, (4) chemicals and non-metallic minerals, (5) basic metals and fabricated metal products, (6) electronic and electrical equipment, (7) machinery and equipment, (8) transport equipment, and (9) other manufacturing. The administrative and support service activities category is similarly divided into five medium categories: (1) logistics, transportation, accommodation, food and beverages, (2) information and communication, (3) finance and insurance, (4) real estate, and (5) other services.

How can we combine these vast amounts of data covering 36 industries in 69 countries and

regions? For a more detailed examination of the TiVA structure than is provided in Fig.2, please refer to Column 1 at the end of this article, which describes the processes used to create international input-output tables.

Generally two types of trade statistics are used: customs-based statistics and balance of payments statistics. TiVA statistics are only compatible with the latter[4]. As shown in Fig.2 above, this means that while TiVA statistics are often compared with gross(transaction)-based or value added-based trade statistics, they are never compared with customs clearance statistics. Trade statistics based on customs clearance data do not include services, while TiVA statistics capture transactions not only in goods, but also in services. Moreover, while trade statistics based on customs clearance data record cross-border transactions in goods without reference to ownership, TiVA statistics do not record transactions that do not involve transfers of ownership, such as intra-company transactions[5].

In fact, gross-based TiVA statistics show that in 2015, exports from the United States amounted to $2,023.9 billion. This is significantly higher than the figure based on customs clearance statistics, which was $1,504.6 billion. The difference reflects the fact that the former includes substantial amounts of service exports. In contrast, Singapore's gross-based exports amounted to $298.4 billion, compared with $330.7 billion on a customs clearance basis. This difference is attributable to Singapore's thriving transit trade. Because TiVA statistics reflect cross-border transactions in value added, including services, they are not suitable for comparisons with trade statistics based on customs clearances.

(2) What We Can Learn from Value Added Trade Statistics

By using TiVA data, we can clarify patterns that were not previously apparent. First, there are significant differences in bilateral trade, depending on whether it is calculated on a value added basis or a gross basis. As illustrated by the iPhone example, China's exports to the United States contain substantial value added produced in other countries and are worth less when calculated on a value added basis than on a gross basis. China's trade surplus with the United States is also smaller on a value added basis (Fig.3). In 2015, China's trade surplus with the U.S. was $251.5 billion on

Fig. 3 China-US Trade—Difference between Gross Basis and Value Added Basis
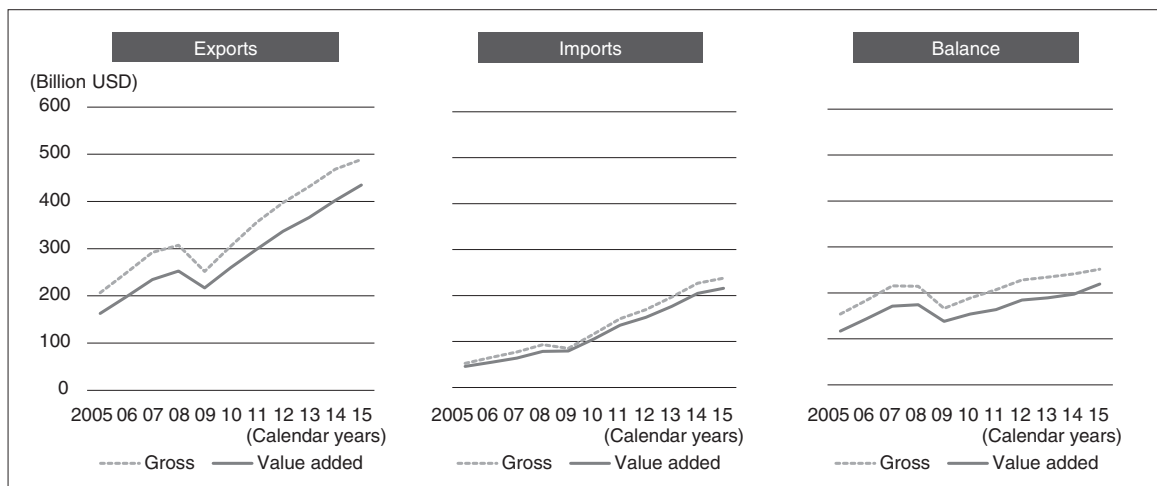
Source: Compiled by JRI using OECD, *TiVA December 2018*

a gross basis, but on a value added basis it was equivalent to 87.2% of this figure at $219.2 billion. This situation will not change significantly in the short-term, and even in 2018 China's trade surplus with the U.S. would have been 10% lower if calculated on a value added basis.

In contrast, Japan's exports to the United States are higher on a value added basis than on a gross basis, because it exports value added to the United States via third countries, such as China. In contrast with China, therefore, Japan's trade surplus with the United States is higher on a value added basis than on a gross basis. In 2015, the Japan-US trade surplus was $26.4 billion on a gross basis, but on a value added basis it was around 1.3 times higher at $33.3 billion (Fig.4). The Trump administration wants China to reduce its trade surplus with the United States, but China's trade surplus, as calculated on a gross basis, is being inflated by exports to the United States via China from Japan and other countries.

There are also considerable differences in Japan's biggest export destinations, depending on whether export statistics are calculated on a gross basis or a value added basis. On a gross basis, China overtook the U.S. in 2008 to become Japan's single largest export destination, but on a

value added basis, the figures for China and the United States are roughly equal, and the United States remained Japan's biggest export destination as of 2015 (Fig.5). This shows that while bilateral trade patterns appear different depending on whether the statistics are based on gross or value added, because double-counting of exports is reflected in imports, there is no difference in each country's overall trade balance as calculated on a gross basis or a value added basis.

Second, exports include value added from other countries. Many multinational corporations, including those from Japan, have built global value chains by establishing production sites in East Asian developing countries through direct investment. As a result, their exports include a high percentage of foreign value added, which is value added produced in other countries. Through the following analysis, we will ascertain the level of foreign value added included in exports from Vietnam. Vietnam has been selected as a case study because it has succeeded in massively expanding its exports by attracting interest as the most promising candidate for the transfer of production sites currently concentrated in China.
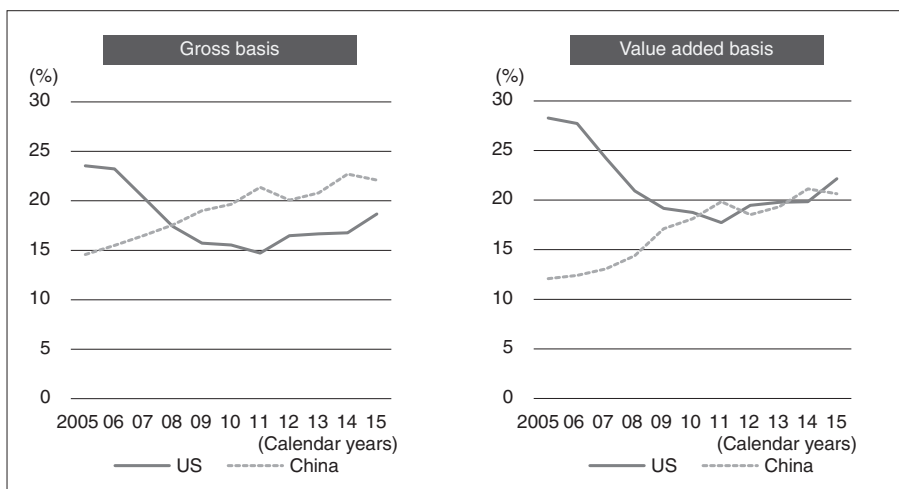
On a gross basis, Vietnam's exports expanded by a factor of 4.2 over a 10-year period, from

Fig. 4 Japan-US Trade—Difference between Gross Basis and Value Added Basis
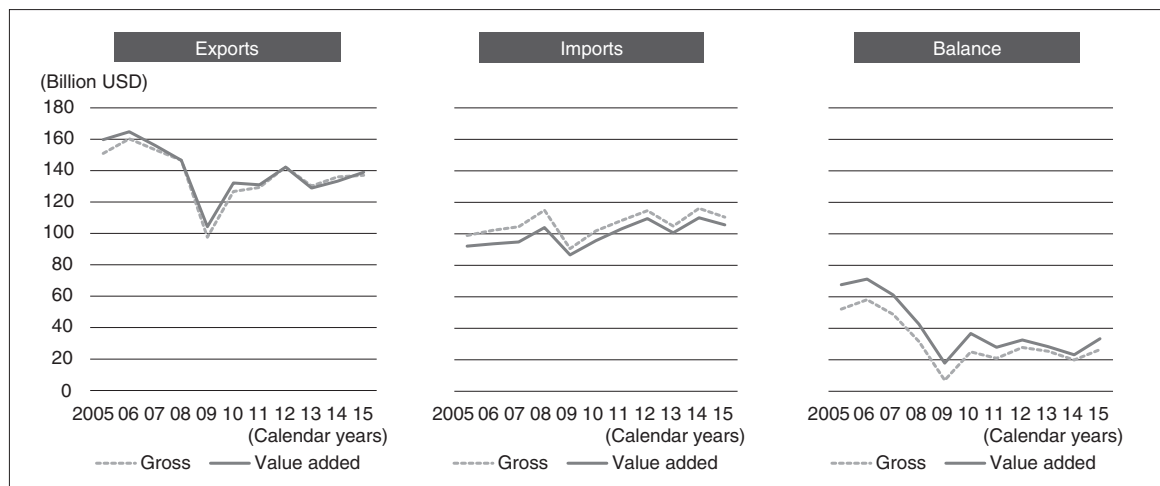
Source: Compiled by JRI using OECD, *TiVA December 2018*

Fig. 5 Percentages of Japanese Exports Destined for the U.S. and China
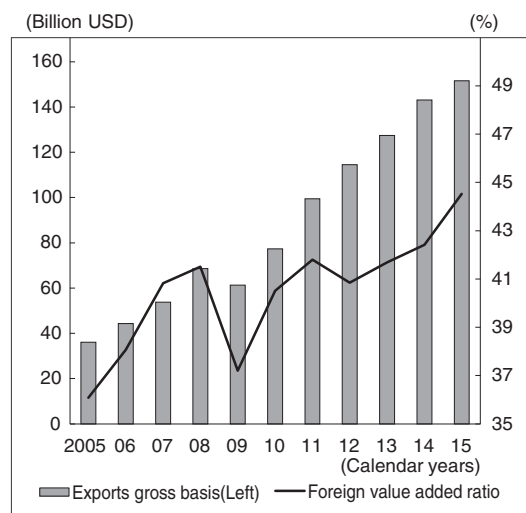

Source: Compiled by JRI using OECD, *TiVA December* 2018

$36.1 billion in 2005 to $151.6 billion in 2015. This dramatic growth is equivalent to an average yearly growth rate of 15.4% (Fig.6). The percentage of foreign value added in Vietnam's exports has risen every year with the exception of 2009, which marked the onset of the global financial crisis, and by 2015 it was 7.5% percentage points above the 2005 level at 44.5%. This is the highest ratio in the world and is comparable to the figures for Hungary (44.1%) and Slovakia (44.5%). Vietnam joined ASEAN in 1995, while Hungary and Slovakia became European Union (EU) members in 2004. Inclusion in global value chains in East Asia and Europe has caused the foreign value added ratios for all three countries to rise.

If we use TiVA data to identify sources of foreign value added, we find that as many as 41 countries and regions contributed at least 0.1% of the value added included in Vietnam's exports. The top five contributors in 2015 were China, followed by South Korea, Japan, the United States and Taiwan. The increase in the contribution from China has been especially conspicuous (Fig.7). While Vietnam has clashed with China concerning sovereignty over the Spratly and Paracel Islands in the South China Sea, it has also become increasingly reliant on China because its export

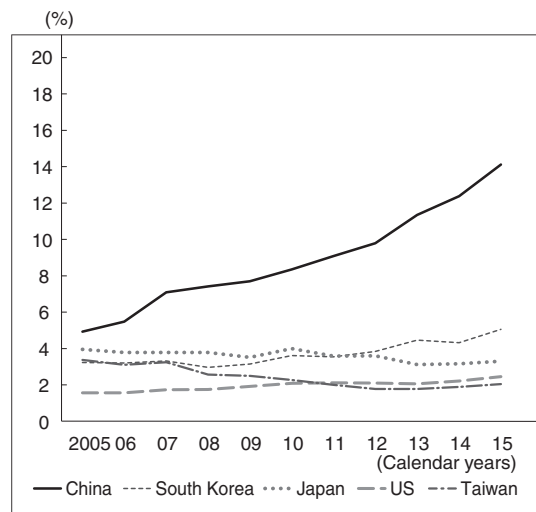## Fig. 6 Exports (Gross Basis) and Foreign Value Added Ratio for Vietnam

Source: Compiled by JRI using OECD, *TiVA December 2018*

industries cannot survive without imports of Chinese intermediate goods. As illustrated by Japan's relationship with China, bilateral interdependence in trade between neighboring countries is not always reflected in political relationships.
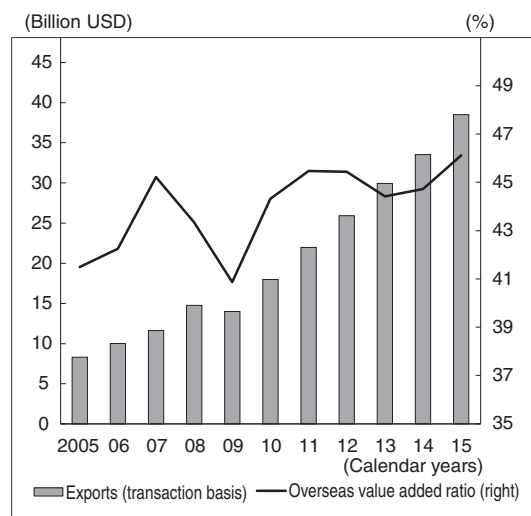
The source of value added can be tracked not

Fig. 7 Exports (Gross Basis) and Foreign Added Value Ratios for Top Five Countries/Regions for Vietnam

Fig. 8 Textile Exports (Gross Basis) and Foreign Value Added Ratios for Vietnam

Fig. 9 Textile Exports (Gross Basis) and Foreign Value Added Ratios for Top Five Countries/Regions for Vietnam

only by country but also at the industry level. We will look next at the dynamic changes that have occurred in Vietnam's textile industry. Because of its low labor costs, Vietnam has increasingly been seen as an alternative production base to China, with the result that textile manufacturing has grown into a major export industry, accounting for one-quarter of Vietnam's total exports. Compared with other manufactured goods, textiles have few parts and involve few processes. For this reason, textile manufacturing is seen as an industry for which the foreign value added ratio is likely to fall. However, Vietnam's ratio has generally followed an upward trend (Fig.8).

In fact a breakdown of the foreign value added ratio for the Vietnamese textile industry shows that there has been a conspicuous increase in China's contribution, which at 19.4% in 2015 was 11.7 percentage points above the 2005 figure of 7.7% (Fig.9). While sewing processes have shifted from China to Vietnam due to lower labor costs, Vietnam lacks the industrial clustering needed to supply the necessary intermediate goods cheaply and reliably. As a result, export growth has been paralleled by growth in imports of intermediate

goods from China. Rising labor costs appear to be eroding the competitiveness of China's labor-intensive export industries. Despite this, China's share of value added exports by the world textile

industry stood at 42.6% in 2015, followed by India (5.1%), Italy (4.9%), and Vietnam (4.5%).

Third, exports include substantial amounts of value added produced by service industries. The concept of export industries is generally associated with manufacturing, and the sources of competitiveness for those industries are assumed to be unrivalled leadership in technology, attractive prices, and the creativity needed to supply consumers with new value. However, before industrial products can be supplied to end users, manufacturers require the support of various service industries in such areas as logistics, advertising, and retailing. In addition, to remain highly competitive, manufacturers need to invest heavily in R&D, while high-quality maintenance and after-sales services are essential to the improvement of customer satisfaction. All of these aspects are classified as services.

Exports include substantial inputs from service industries as well as from manufacturing. This is readily apparent from analyses based on value added. For example, manufacturing accounts for around 70% of Japan's exports on a gross basis, but on a value added basis the contributions from manufacturing and services are roughly equal (Fig.10). Because the value added provided by service industries is included in product prices, the manufacturing sector accounts for 70% of value added on a gross basis, but when calculated on a value added basis, which allows us to trace the sources of value added, the ratio falls to 50%.

TiVA statistics are extremely useful, but because a number of assumptions are made when compiling the international input-output tables on which TiVA statistics are based, we need to be aware that the statistics are essentially estimates. To understand why value added trade statistics are estimates, please refer to Column 2 at the end of this article for an analysis of the assumptions made when compiling international input-output tables, and the biases that result from those assumptions. There are certain issues with TiVA statistics, including the low frequency of updates and the age of the data used, but these statistics are the only analytical tool that allows us to understand global value chains. It should be noted that sustained efforts are being made to improve the accuracy of TiVA statistics (Ogino, Tahara, Tokioyama [2017]).

Fig. 10 Percentages of Manufactured Goods and Services in Japan's Exports
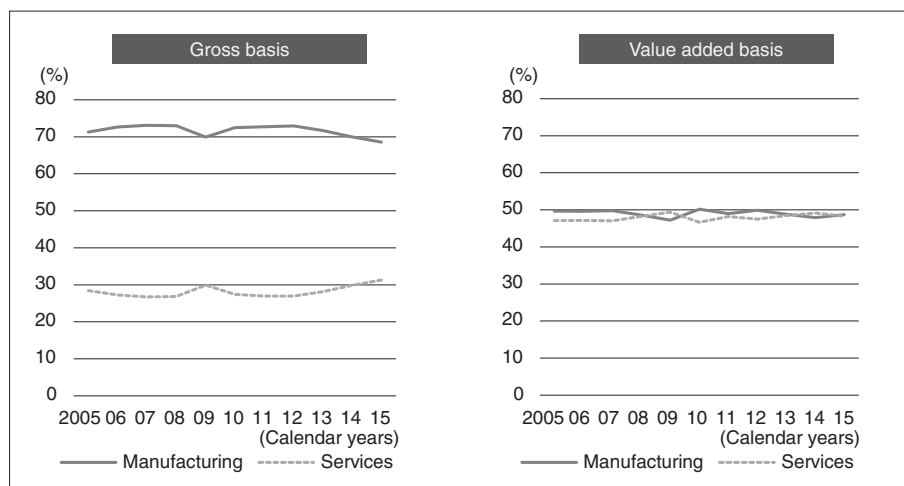
Source: Compiled by JRI using OECD, *TiVA December 2018*

2. Impact of US-China Trade Friction

One area in which value added trade statistics are likely to be used is the measurement of the ways in which trade affects economies. The following analysis looks at the extent to which further escalation of US-China trade friction, which is currently the greatest focus of world attention, would impact on United States and China.

### (1) Scenario 2 the Dividing Line According to IMF Estimates

Various organizations have attempted to estimate how trade friction will impact on the United States and China. Tit-for-tat tariff hikes hurt both sides, leading to a war of attrition with no winners. The tariff increases are also thought to be having a serious impact on global value chains. In October 2018 the International Monetary Fund (IMF) published estimates of how far the real GDP growth rates of the United States, China, the EU, Japan, and the world would decline from the baseline (the growth rate used in the IMF's World Economic Outlook) in the form of scenarios based on a gradual worsening of US-China trade relations (Fig.11).

Under Scenario 1, the United States would raise the tariff rate on Chinese products worth $200 billion from 10% to 25%. Since the Trump administration postponed the implementation of these tariff increases, which was scheduled for March 2, at the end of February 2018 after some progress was made in trade talks, the current situation (as of the end of March 2019) is at the stage before Scenario 1. Under Scenario 2, the U.S. would impose a 25% tariff on the remaining Chinese goods worth $300 billion that have hitherto been exempted from tariffs, and China would retaliate by raising its tariff on U.S. goods to 25%.

Based on the assumption that the trade talks will stall, the IMF has developed Scenario 3, under which the United States would impose a 25% tariff on Chinese automobiles and automotive parts worth $350 billion, Scenario 4, under which uncertainty caused by the deterioration of US-China relations would adversely affect business sector investment intentions, and Scenario 5, under which business earnings would fall by 15%. All scenarios are based on the assumption that the

Fig. 11 Impact of US-China Trade Friction on Real GDP Growth rates of Countries/ Regions
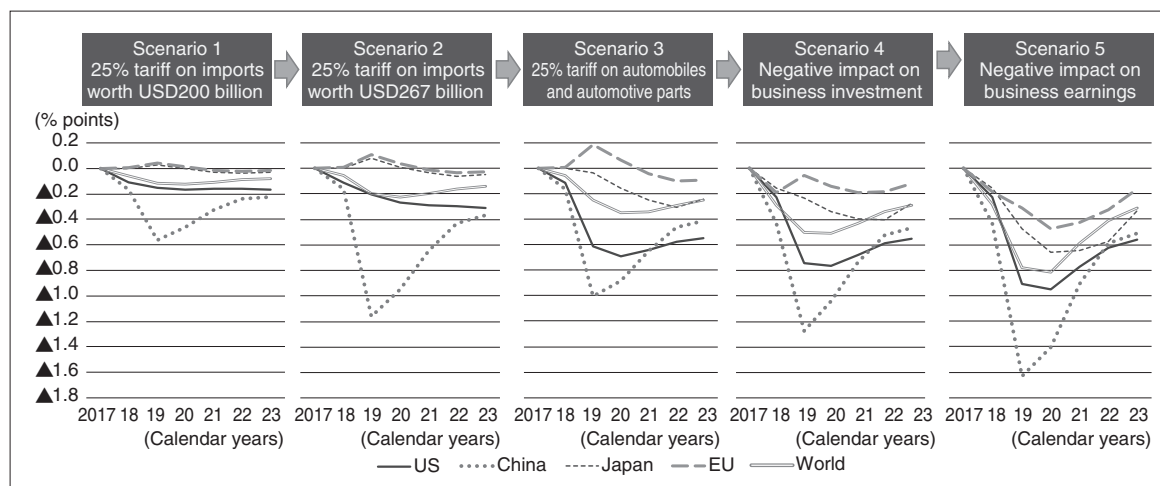
Source: Compiled by JRI using IMF, World Economic Outlook 2018

situations projected in 2018 will eventuate.

The impact of these tariff hikes would be greater in China than in the United States, since China exports more to the United States than the United States exports to China. If we substitute export statistics from the U.S. Census Bureau for the TiVA statistics, which are not based on the latest data, we find that in 2017, China exported goods worth $505.5 billion to the United States, while the United States exported goods worth $129.8 billion to China over the same period (both figures based on customs clearance data)[6]. China's exports to the U.S. were equivalent to 4.1% of its GDP, while U.S. exports to China were worth only 0.7% of U.S. GDP.

China's economic slowdown is viewed with considerable anxiety in Japan, and there was extensive media coverage of the news that Japanese exports to China fell by 17.4% year on year in January 2019. This downturn was attributed not only to the Lunar New Year holidays, but also to the impact of US-China trade friction[7]. However, as long as the United States does not raise its tariffs on $200 billion worth of Chinese goods to 25% and the situation remains at the stage before the IMF's Scenario 1, the impact of trade friction is likely to be minimal not only for China, but also for Japan. It is under Scenario 2 that U.S. tariff hikes would have a major impact on the Chinese economy, since tariffs would be imposed on all products imported from China.

However, the IMF believes that even under Scenario 5, China would be able to avoid an economic slowdown through the use of stimulus measures. At the National People's Congress in March 2019, China lowered its GDP growth rate target from around 6.5% in 2018 to 6.0-6.5% in 2019. Yet it also announced stimulus measures, including (1) a 2 trillion yuan cut in value added taxes and social insurance premiums to reduce the tax burden on manufacturers and small and medium enterprises, (2) a year on year increase of 800 billion yuan in the issuance ceiling for local government bonds, raising the limit to 2.15 trillion yuan, and (3) measures to encourage large state-owned financial institutions to increase lending to small and medium enterprises by 30% over the previous

year's level[8].

As long as the situation remains at the stage before Scenario 1, trade friction between the United States and China will not cause a significant economic slowdown in either country. In fact, the February trade figures, which show a 5.5% increase in Japan's exports compared with February 2018, suggest that the decline in exports in January was attributable to the effect of the Lunar New Year holidays. Within the Chinese economy, growth boosts from stimulus measures and slowdowns caused by domestic factors, such as stagnating domestic demand, appear to be mingled with slowdown pressure from trade friction. However, there is a tendency to blame trade friction for any economic indicators that trigger anxiety about the future outlook.

(2) Value Added Exports—3.2% of China's GDP, 1.1% of U.S. GDP

We will next consider the extent to which trade friction with the United States will cause the Chinese economy to slow down. Japanese companies need to remain constantly focused on this question, but the outlook remains unpredictable because of the continuing fluidity of the trade talks. We cannot be certain how long the talks will continue and what the outcome will be. For this reason, it is difficult to estimate how far China's growth rate will fall under a tightly defined scenario, such as those developed by the IMF. The following analysis looks at two fundamental issues: interdependence between the United States and China on a value added basis, and the extent to which tariff hikes could impact the economies of various countries.

TiVA statistics provide the best resources with which to investigate these two questions. The value of bilateral trade on a gross basis does not necessarily correlate with the level of independence between two countries. As shown in Fig.5 above, China is Japan's biggest export market on a gross basis, while the United States is the biggest market on a value added basis. For this reason, value

added exports provide the best indicator of the depth of economic ties between two countries, as well as the impact of an economic downturn in one country on the other. Furthermore, the ratio to GDP, as calculated by dividing exports by the size of the economy, is the most suitable basis for comparisons of the level of reciprocal influence between economies.

An analysis using value added trade statistics indicates that the percentage of domestic value added included in China's exports to the United States (the domestic value added ratio) was 82.5% as of 2015 (Fig.12, left). This means that foreign value added accounts for 17.5% of China's exports to the United States. For a long time, China's domestic value added ratio for exports to the United States was lower than the ratio for exports to the United States by non-OECD countries. China caught up with those countries in 2014 and overtook them in 2015. Based on the iPhone case study in Fig.1, China's domestic value added ratio is extremely low, but an analysis of the latest data about sources of value added suggests that the ratio has risen substantially.

In fact, an analysis of the 2018 Apple Supplier List[9] by country and region reveals that 41 companies are based in China (including Hong Kong), which is the second highest number after Taiwan

46) and higher than the totals for Japan (38), and the United States (37). In addition, almost one-half of Apple's manufacturing facilities are located in China, indicating that there has been a steady rise in China's presence in Apple supply chain for parts[10]. Of course, this total includes not only local Chinese companies, but also foreign-owned companies that have increased their domestic value added ratios by shifting to local procurement. This means that the domestic value added ratios for local companies may have been overestimated. Nonetheless, it is clear that there has been a steady increase in the depth of industrial clustering in China.

At 91.0%, the domestic value added ratio for the United States was higher than China's ratio in 2015 (Fig.12, right). While developed countries typically have high domestic value added ratios, the U.S. ratio is the highest among OECD members, even exceeding the ratios of countries whose exports include high percentages of resources, such as Australia (90.0%) and Chile (87.6%). This indicates that most of the intermediate goods required for exporting are sourced within the United States, which is indicative of extremely deep industrial clustering. Because both the United States and China have high domestic value added ratios, the impact of any tariff hikes will be felt most by

Fig. 12 Trends in Domestic Value Added Ratios
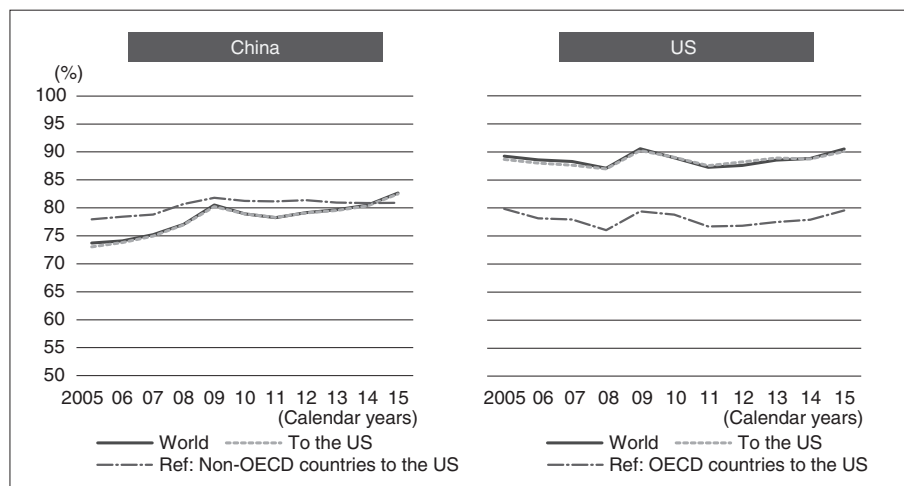
Source: Compiled by JRI using OECD, *TiVA December 2018*

domestic companies, including foreign-owned companies that produce value added domestically rather than those that export goods to the United States and China via their home countries.

To what extent will the U.S. and Chinese economies be impacted by export stagnation triggered by tariff increases? TiVA statistics are also well suited for answering this question because they are based on value added, like GDP. In 2015, value added produced in China and included in exports to the United States was equivalent to 3.6% of China's GDP, and 1.2% of U.S. GDP (Fig.13). According to the Census Bureau of the U.S. Department of Commerce, Chinese exports to the United States in 2015 were equivalent to 4.4% of GDP, while the corresponding ratio for U.S. exports to China was 0.6%. This suggests that on a customs clearance basis, the impact on China has been overestimated, and that the impact on the United States has been underestimated. The main reasons for this are the fact that China's exports include more foreign value added than U.S. exports, and the fact that U.S. exports do not include services.

As is apparent from Fig.13, there has also been a gradual decline in the significance of exports

to the United States for the Chinese economy. In 2006, exports to the United States accounted for 6.7% of China's GDP, but this ratio had fallen to 3.9% by 2009 and been falling gradually since then, reaching 3.6% in 2015. Reasons for this include the growth of China's exports to neighboring Asian countries and Africa due to its efforts to encourage direct investment in other countries under its "Go Out" policy, and the expansion of its development assistance loan program. From just 22.0% in 2005, the percentage of China's value added exports destined for non-OECD countries had climbed to 35.3% by 2015. At the same time, the influence of exports to China on U.S. economic trends has gradually strengthened. This pattern, which is common to many countries, is attributed to the expansion the Chinese economy.

According to the United Nations Conference on Trade and Development (UNCTAD), if the United States increases its tariffs on Chinese imports worth $200 billion from 10% to 25%, the trade diversion effect will cause 82% of China's exports to the United States to be replaced with exports from third countries that enjoy lower tariffs, with the result China would only be able to maintain 12% of its export trade with the United States (UNCTAD [2019]). At the same time, 85% of U.S. exports to China would be substituted, so American companies would be able to maintain only 10% of their export trade with China. If we calculate the value added that could be lost due to tariff hikes by applying these percentages to the graph in Fig.13, we find that China would lose 3.2% of its GDP, while the U.S. would lose 1.1%.

US-China trade friction is generally seen as being more disadvantageous to China, which is heavily dependent on exports. However, the disadvantage is not solely on the Chinese side for several reasons. First, on a value added basis, Chinese exports to the United States are equivalent to 3.2% of GDP, compared with 1.1% for the United States. The difference is smaller than indicated by customs clearance statistics (4.4% and 0.6%, respectively). Second, as the IMF has pointed out, China can offset the impact of higher tariffs through stimulus measures. Third, the Trump administration cannot easily expand the range of

Fig. 13 Value Added Exports to the U.S. and China as Percentages of GDP

(%)
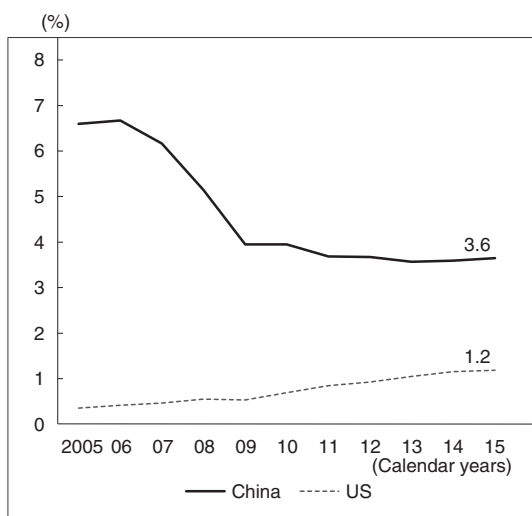
Source: Compiled by JRI using OECD, *TiVA December 2018*

Fig. 14 Exports to the Other Country as a Percentage of GDP
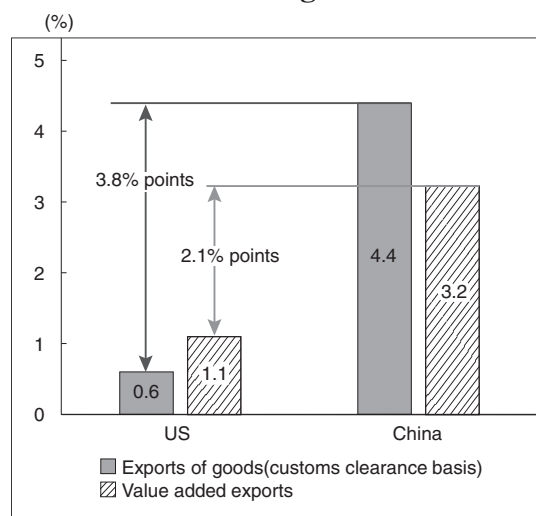
Source: Compiled by JRI using OECD, *TiVA December 2018*

items affected by the tariff increases because of the implications for the presidential election.

(3) Impact on Individual Industries— Manufacturing in China, Services in the United States

Most estimates of the impact of tariff increases, including the IMF estimates, focus on the effect on growth rates and do not look at the implications for individual industries with differing levels of reliance on exports to the United States. However, the effects of the tariff increases are believed to be emerging already. For example, in 2019, a toy manufacturer in Shenzhen City, Guangdong Province was driven into bankruptcy[11]. If the United States raises its tariffs on Chinese goods to 25%, and China retaliates, export competitiveness will be eroded, and some estimates suggest that as many as two million jobs will be lost[12].

There are likely to be more news reports about worsening business performance in specific regions and industries. Yet employment trends in both the United States and China remain stable. According to a 2018 survey, Shenzhen City's

unemployment rate was steady at around 5%, and the city has set a bullish target of 5.5% for 2019[13]. Nor have been there been any reports about emerging impacts from trade friction or slower job growth in the United States. To determine which industries are being impacted by the trade friction, we will look at the industry structure of value added trade as reflected in TiVA statistics.

An industry breakdown of China's value added exports to the United States shows that the manufacturing sector accounts for the largest share (Fig.15, left). The individual industry with the largest share in 2015 was chemicals and non-metallic minerals (11.0%), followed by electronic and electrical equipment (9.8%), textiles (9.5%), and base metals and processed metal products (6.9%) (Fig.16). However, the Trump administration has exempted items that have a major impact on people's lives from the sanctions, which means that not all of the industries listed in Fig.16 will be affected by the tariff hikes.

The United States has imposed an additional 10% tariff on 5,173 items worth $200 billion. If we classify these goods according to their two-digit Harmonized Tariff Schedule (HTS) codes, we find that the categories in which a large numbers of items are affected are (1) organic chemicals, (2) fish, crustaceans & aquatic invertebrates, (3) inorganic chemicals, and (4) cotton (Table 1). From this we can see that there is no correspondence between ISIC product categories with many items subject to additional tariffs, and product categories in which the value of trade between United States and China is high. In fact, there are few textile items (ISIC: 13-15) or electronic and electrical equipment (ISIC: 26-27) in the list of items subject to tariffs as published by the Office of the United States Trade Representatives (USTR [2018])[14].

Some Japanese media reports have highlighted the impact of tariff increases as one of the causes of the 28.6% year on year fall in China's exports to the United States in January-February 2019[15]. However, if we compare product categories in which China exports substantial quantities of products to the United States with those affected

Fig. 15 Industry Shares of Value Added Exports to the U.S. and China
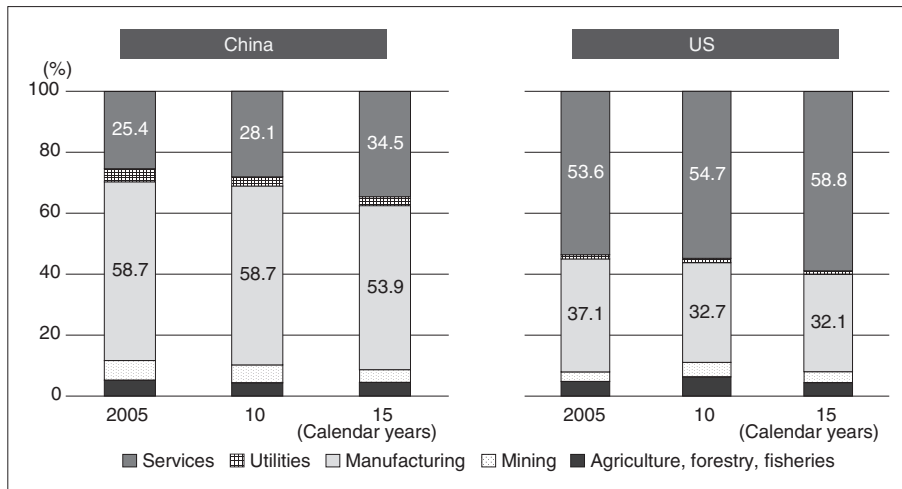
Source: Compiled by JRI using OECD, *TiVA December 2018*

Fig. 16 Manufacturing Industries' Share of Value Added Exports to the U.S. (2015)
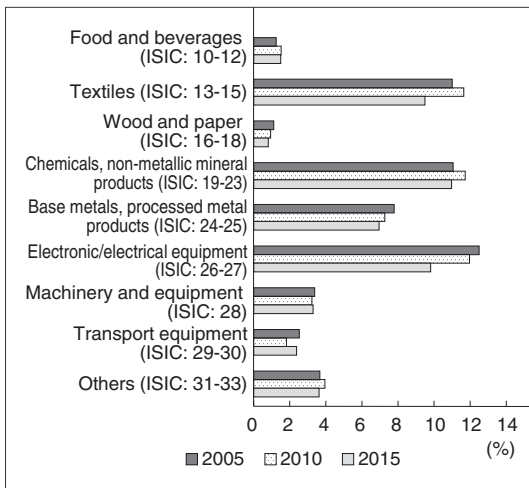
Source: Compiled by JRI using OECD, *TiVA December 2018*

by the punitive tariffs, it becomes apparent that the impact will not emerge until the stage at which the higher tariffs are applied to all items imported from China, which is the situation posited in the IMF's Scenario 2. First, the United States imposed additional tariffs in July 2018. Second, given that Chinese exports to the United States remained strong in 2018 with 17.2% year on year growth, we can reasonably conclude that the recent decline in Japan's exports to China is primarily due to sluggish domestic demand in China, as symbolized by stagnating sales of smartphones and automobiles, rather than the U.S. tariff increases.

An industry breakdown of value added exports from the United States to China reveals that in contrast with China's export mix, the industries impacted by tariff increases would be services rather than manufacturing industries (Fig.15, right). According to a previous study on this question, once the transition to Scenario 2 occurs, even if the United States finds alternate sources for imported goods currently purchased from China, the additional costs would be added to prices, resulting in the loss of 2.16 million jobs in the United States over a three-year period (Trade Partnership Worldwide [2019]).

If we break this figure down by industry, we find that while the number of manufacturing industry jobs would grow by 236,000, 70,000 jobs would be lost in the agriculture, forestry and fishery sector and 2,307,000 in the service sector. Service industries that would be likely to suffer significant job losses include wholesaling and retailing (482,000 jobs), construction (413,000 jobs),

Table 1 Items Affected by Additional Tariffs on Chinese Products Worth $200 Billion

Ranking	HTS 2-digit	ISIC 2-digit	Description	Number of Items
1	29	20,21	Organic chemicals	694
2	03	03,10	Fish, crustaceans & aquatic invertebrates	275
3	28	20	Inorganic chemicals, valuable organic/inorganic compounds	231
4	52	13	Cotton	230
5	48	17	Pulp, paper and paperboard	222
6	85	26,27	Electrical machinery, equipment, and parts	213
7	84	20,25,26,28,29,30	Nuclear reactors, boilers, machinery, mechanical equipment	196
8	44	16	Wood, articles of wood, wood charcoal	180
9	38	20	Other chemicals	142
10	07	07,10	Edible vegetables and certain roots and tubers	143
Others				3,220
Total				5,745

Notes: Number of items are based on 8 digit of HS code.
Source: Compiled by JRI using Ernst & Young [2018]

and business services (324,000 jobs). These estimates are based on international input-output tables compiled by Purdue University in the United States for Global Trade Analysis Project (GTAP). They point to the same conclusion as the TiVA statistics, which indicate that the service sector would inevitably suffer the severest effects.

If US-China trade friction escalates to the Scenario 2 stage, the real economy would start to be impacted by increasing pessimism about the future, with severe implications for companies that have close ties with China. For example, in November 2018, Apple's share stock price fell after President Trump commented that a tariff might be imposed on iPhones. In China, the business performance of labor-intensive export industries is expected to deteriorate. While the Chinese government is utilizing press censorship to hide the impact of trade friction, the effects of the situation are becoming apparent in China's coastal regions with large numbers of exporting companies.

The tariff increases are already having a conspicuous effect in Guangdong Province. For example, the average profit for industrial enterprises fell by 0.1% year on year in 2018[16]. This is far below the 2017 growth rate of 15.7%[17] and the national average of 10.3%[18]. According to the provincial government, the number of new jobs created in 2018 was close to the previous year's level at 1.48 million. However, the 0.2% profit growth rate for service sector companies was far below the 2017 increment of 22.6% and the national average of 6.5% growth. This indicates that Guangdong Province no longer has any industries that actually support employment. Given that Guangdong accounts for around 30% of China's total exports, the effects of escalation to Scenario 2 would probably be especially pronounced in the province.

3. Impact on Neighboring Asian Countries and Regions, Including Japan

The effects of the tariff hikes resulting from US-China trade friction will also spread to neighboring economies. Ripple effects can propagate along various channels, and the impact could vary considerably according to country or region. However, the focus at present is on the implications for countries if the tariff increases cause a slump in exports to the United States via China.

(1) Impact by Country/Region – Backflow through GVCs to Taiwan, South Korean, and ASEAN

The foreign value added included in China's exports to the United States makes up less than 20% of China's total exports. On a gross basis, however, China's exports to the United States in 2015 amounted to $489.2 billion, or 3.6 times Japan's total of $137.0 billion. For this reason, US-China trade friction will have a significant impact on countries and regions that use China as their final base for exports to United States. Because the extent of that impact cannot be gauged from customs clearance statistics, the countries and regions concerned naturally remain nervous about the outlook for trade friction and trends in exports to China. We will attempt to ascertain the scale of the impact using TiVA statistics.

A breakdown of value added from other countries/regions that is included in China's exports to the United States by country and region shows that South Korea has the largest share at $10.3 billion, followed by the United States at $9.6 billion, and then Taiwan and Japan at $8.3 billion each (Fig.17, left). As illustrated by the iPhone

case study, South Korea, Taiwan and Japan are the leading suppliers of various intermediate goods to China's export industries. Under the IMF's Scenario 2, trade friction between the United States and China could deprive these countries of destinations for their added value.

The appearance of the United States in this list may seem surprising, but a breakdown of the value added of goods exported to China by the top four countries reveals that manufacturing accounts for a smaller share of exports from the United States compared with the other countries, while the contribution from the service sector is high (Fig.18). This can be attributed to re-exporting of value added produced in the United States through upstream production processes, such as R&D and design for product development. The level of value added along production process flows is manifested as a "smile curve". The service sector's contribution to exports of intermediate goods to China is an indicator of the positioning of each country and region in the production processes for which assembly operations are carried out in China.
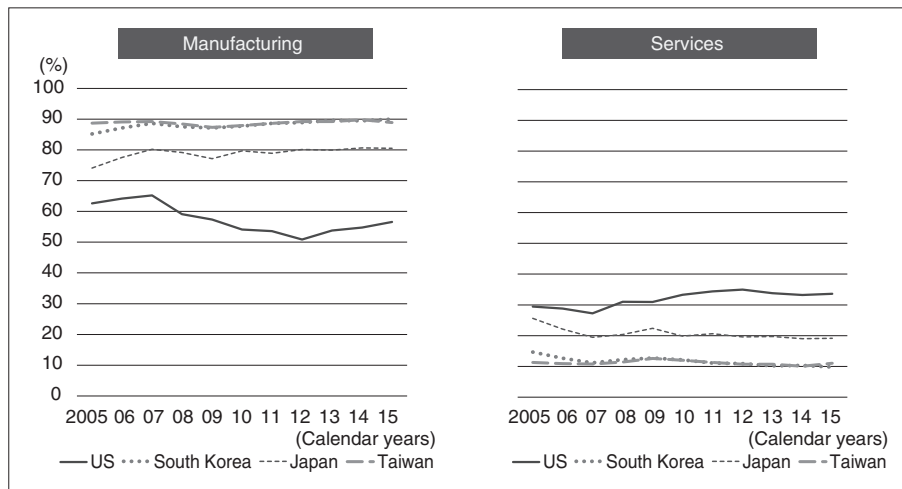
Because the economic scale of each country and region is different, the size of their contributions to the value added of exports to China is

Fig. 17 Value Added from Other Countries/Region Included in Chinese Exports to the U.S. (2015)
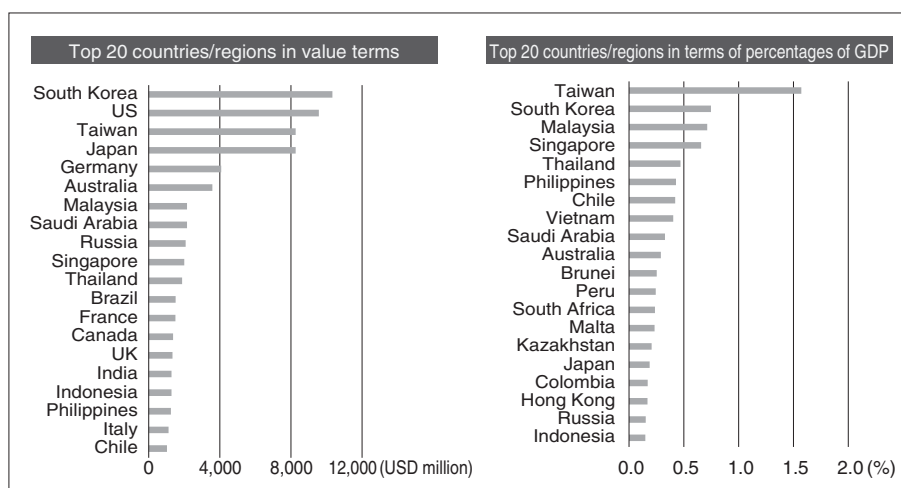
Source: Compiled by JRI using OECD, *TiVA December 2018*

Fig. 18 Industry Shares of Exports of Intermediate Goods to China

Source: Compiled by JRI using OECD, *TiVA December 2018*

not necessarily proportionate to the impact on their economies. Taiwan has the highest ratio of value added to GDP at 1.6%, followed by South Korea (0.7%), Malaysia (0.7%), and Singapore (0.7%) (Fig.17, right). Thailand and Vietnam are also among the countries with high ratios. This indicates that the impact of tariff increases by the United States would spread to East Asian countries that are closely interdependent with China in the form of backflow through East Asian GVCs.

Assuming, as discussed earlier, that imports from third countries that enjoy lower tariff rates are substituted for 82% of China's exports to the United States through the "trade diversion" effect, the value added exports to the United States via China that could be lost under the IMF's second scenario would be equivalent to 1.3% of GDP for Taiwan, 0.6% for South Korea and Malaysia, 0.5% for Singapore, 0.4% for Thailand and the Philippines, and 0.3% for Vietnam. While the impact on Japan would be relatively small at 0.2% of GDP, because Japan's growth rate is already low, the perceived impact may be greater than in the Philippines and Vietnam, which have high growth rates.

We also need to be aware that the figure of 0.2% is not an indication that Japanese companies are not supplying large amounts of intermedi-

ate goods to China's exporting industries. Japan's value added exports to the United States via China are comparable in scale to those of Taiwan. They simply appear smaller compared with the scale of the Japanese economy. Furthermore, the cumulative total of Japanese direct investment in China up to 2017 was $100.6 billion, which is far higher than the totals for Taiwan ($59.7 billion) and South Korea ($71.1 billion). This means that Chinese value added exports to the United States include a significant amount of value added produced by Japanese companies that have expanded into China. The impact of U.S. tariff increases would probably be manifested in worsening business performance for these companies.

(2) Impact by Industry—Especially the Electrical and Electronic Industries

Which sectors will be affected in China's Asian neighbors? An analysis of value added produced in countries and regions other than China and included in China's exports to the United States shows that in period from 2005 to 2015, manufacturing industries consistently accounted for around 90% of the exported added value. The

contributions of individual industries to the total contribution from the manufacturing sector in 2015 include 37.9% from the electronic and electrical equipment industry, which was the biggest single contributor, followed by textiles (17.5%), chemicals and non-metallic minerals (10.0%), others (9.1%), machinery and equipment (8.3%), and basic metals and processed metal products (7.1%) (Fig.19). Since the main items produced through East Asian global value chains with China as the final export base are electronic and electrical equipment, PCs, and smartphones, we can conclude that these industries will be susceptible to the effects of US-China trade friction.

Are there differences in the industry breakdown of foreign value added included in China's exports to the United States according to country or region? Contributions from the electronic and electrical industries are as high as 60-80% in the case of Taiwan, South Korea, the ASEAN economies and Japan, all of which are ranked high in the list of GDP ratios on the right side of Fig.17 (Fig.20). For this reason, we can assume that if US-China trade friction escalates to Scenario 2, the effects would be concentrated in the electronic and electrical industries. Value added included in China's exports represents particularly large shares of

GDP in the case of Taiwan and South Korea, which means that the impact on these countries would be severe.

In fact, as long as US-China trade friction remains at the stage before Scenario 1, Taiwan will not be significantly affected. If there is a transition to Scenario 2, however, there would be a major impact, and companies in the electrical and electronic industries, such as the leading PC manufacturer Quanta Computer, are starting to shift some of their production operations back to Taiwan[19]. There is growing concern in Taiwan that the Taiwanese economy has become overly dependent on China. In addition to the repatriation of business operations to Taiwan, companies are also likely to disperse their production sites to Vietnam and other ASEAN countries. As discussed later in this article, however, manufacturing bases established to supply domestic demand in China have become a lifeline for the Taiwanese economy. Since not all of these sites can be relocated out of China, Taiwan cannot easily avoid the risk of an economic slowdown in China.

Furthermore, companies cannot relocate their production sites overnight. The scope for relocation back to Taiwan would be limited by the availability of land and human resources, and it would

Fig. 19 Foreign Value Added Included in Chinese Exports to the U.S. by Industry (Manufacturing)
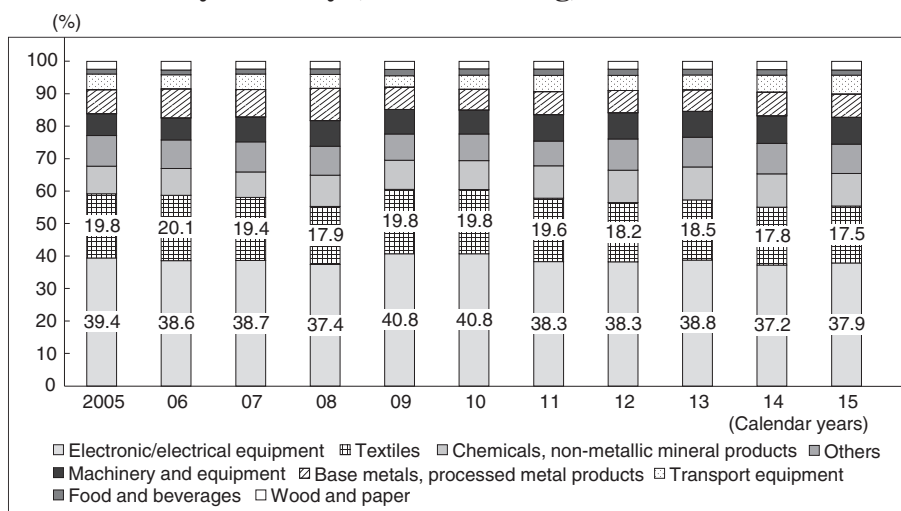
Source: Compiled by JRI using OECD, *TiVA December 2018*

Fig. 20 Value Added from Other Countries/Regions Included in Chinese Exports to the U.S. by Industry (Manufacturing)
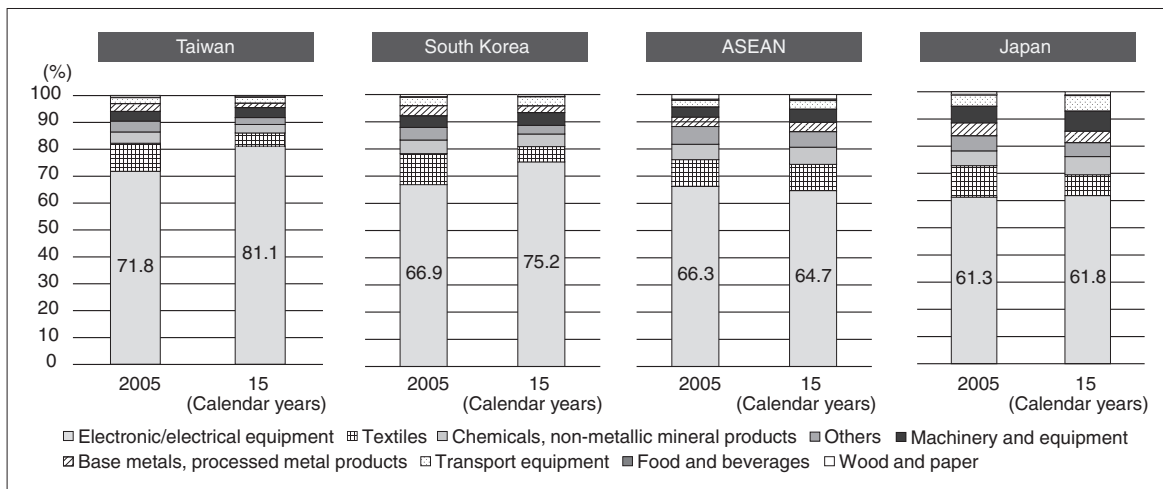
Notes: ASEAN consists of eight countries excluding Laos and Myanmar.
Source: Compiled by JRI using OECD, *TiVA December 2018*

also be necessary to make radical policy changes, such as the acceptance of foreign workers. The scope for relocation to third countries would also be limited, since there are few countries with which Taiwan has established diplomatic relations. In addition, companies would face increased costs because of the small number of countries with which Taiwan has signed FTAs. Some in Taiwan view US-China trade friction positively as an opportunity to reduce Taiwan's reliance on China. However, there is no definitive consensus about the best approach to the relocation of production sites, or whether relocation is even feasible.

Intermediate goods exported to the United States via China make up only 5% of South Korea's total exports to China, and it is estimated that even if exports to China via the United States are included, the impact of the US-China trade friction would be minimal at around 0.05% of South Korea's GDP[20]. This is significantly smaller than the 0.6% figure cited above. One reason for this is the fact that South Korea has made more progress than Taiwan toward the dispersal of its production sites. For example, Samsung has smart phone production sites not only in China, but also in Vietnam and India, while its television production sites are located worldwide. This trend has accel-

erated since the controversy over South Korea's decision to deploy the THAAD ground-based missile interceptor system. Within South Korea, there is also a perception that South Korean companies would benefit both from the erosion of the competitiveness of Chinese products in U.S. markets, and also from a decline in the competitiveness of U.S. companies in Chinese markets[21].

However, South Korea also faces risks to which Taiwan is not exposed and may have become a target for the protectionist policies of the Trump administration. For example, when the free trade agreement (FTA) between South Korea and the United States was renegotiated in March 2018, South Korea was forced to introduce quotas limiting the amount of steel exported from South Korea to the United States, as an alternative to tariff exemptions for imported steel. One view is that in the long run South Korean companies will inevitably need to expand their production either in the United States, or in Mexico, where they can gain access under the United States-Mexico-Canada Agreement (USMCA) framework, while also developing new markets in South America and other regions[22].

The outlook for the ASEAN economies is more optimistic than that for Taiwan and South Korea

because their contributions to value added included in Chinese exports to the United States are relatively small, and there is the expectation that they will be able to play both sides against the middle and benefit from the trade diversion effect. For example, if trade friction escalates to Scenario 2, with 25% tariffs applied to the remaining items worth $267 billion, the Vietnamese textile industry, which is East Asia's biggest exporter to the United States after China, would be likely to replace China as a base for exporting to the United States. Samsung already uses Vietnam as an export base for smartphones, while Taiwanese contract manufacturers of Apple products are preparing to establish new production sites in Vietnam and Indonesia[23]. Vietnam is therefore likely to attract increasing attention from the electronic and electrical industries as a base for exporting to the United States.

(3) Guarding Against a Second Wave

So far we have only looked at value added from other countries and regions that is included in China's exports to the United States. Obviously, the value added that these countries and regions export to the United States and China directly rather than via China far exceeds the amount included in Chinese exports to the United States. If US-China trade friction continues to escalate and reaches Scenario 4, which would have an adverse effect on corporate investment, or Scenario 5, which would cause business performance to deteriorate, the countries and regions concerned would be severely impacted by a slump in exports to the United States and China. If the impact of US-China trade friction on value added from each country and region that is included in China's exports to the United States can be called the "first wave", then this situation would constitute the "second wave".

We will conclude by verifying the potential scale of this "second wave". As pointed out at the beginning of this article, while China is Japan's largest export destination on a transaction basis,

the United States is the biggest destination on a value-added basis. Is the same true of other Asian countries and regions? An analysis of the scale of value added exports from each country and region to United States and China as percentages of GDP, shows that all countries and regions other than Japan are rapidly becoming more reliant on China, which means that they are more likely to be influenced by Chinese economy than the U.S. economy (Fig.21).

An economic slowdown in China would have a particularly serious impact on Taiwan, which in 2015 earned 13.4% of its GDP from value added exports to China. While South Korea and ASEAN are less reliant on China with figures of 7.5% and 5.2% respectively, they would still be significantly impacted, albeit not as severely as Taiwan. Japan's ratio is only 2.9%. According to an estimate by the Asian Development Bank, a 1.6% fall in China's growth rate would cause export declines of 0.7 percentage points for Taiwan, 0.5 percentage points for South Korea, 0.4-0.8 percentage points for ASEAN, and 0.6 percentage points for Japan (Zhai and Morgan [2016]). However, the fact that the Chinese government has set a growth rate target of 6.0-6.5% for 2019 suggests that these impacts would likely be offset by the effects of stimulus measures.

While Japan might be less affected than other countries and regions by an economic slowdown in China, this does not mean that it is disconnected from global value chains in East Asia. Japan would feel the effects of an economic slowdown in China not only from China, but also through the resulting economic slowdowns in Taiwan, South Korea and the ASEAN economies. Japan's value added exports to these countries and regions account for 17.2% of its total value added exports and 2.1% of its GDP, a ratio that is exceeded only by China (2.9%) and the United States (2.9%).

According to the IMF (Kireyev and Leonidov [2015]), today's heightened trade interdependence means that a macroeconomic shock in one country can, if that country's economy is large, ripple out to other countries and regions as a first wave through reduced exports to that country. However, economic slowdowns in neighboring countries

Fig. 21 Value Added Exports to the United States and China (Percentages of GDP)
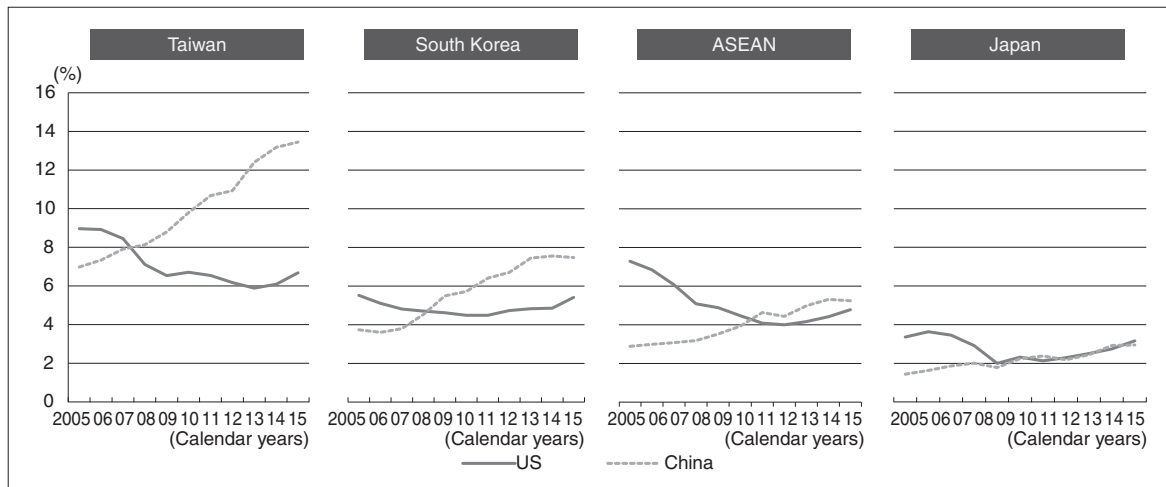
Notes: ASEAN consists of eight countries excluding Laos and Myanmar.
Source: Compiled by JRI using OECD, *TiVA December 2018*

and regions can also ripple back to the country that was the source of original shock, generating second and third waves that have even a greater impact than the first. Optimism about the future has spread since the United States decided to postpone tariff increases on Chinese products on March 2 following trade talks with China. However, it would be premature to say that a second-wave impact is unlikely.

Conclusions

In this article we have examined the ways in which US-China trade friction is likely to impact on both countries and on China's Asian neighbors under the IMF scenarios, by focusing on value added exports. This analysis points to the following conclusions.

Some observers in Japan believe that trade friction is causing the Chinese economy to slow down, but the Chinese economy will not be seriously impacted by U.S. tariff increases until the situation escalates to Scenario 2, under which higher tariffs would be applied to all products imported from China. The value added exports to the United States that could be lost by China through a transition to Scenario 2 would be equivalent to 3.2% of China's GDP and 1.1% of the GDP of the

United States. The manufacturing sector would be impacted heavily in China, and the service sector in the United States.

A similar analysis of the effects of a transition to Scenario 2 on China's Asian neighbors, including Japan, shows that Taiwan would suffer the greatest impact at 1.3% of GDP, followed by South Korea (0.6%), Malaysia (0.6%), Singapore (0.5%), Thailand and the Philippines (0.4%), Vietnam (0.3%), and Japan (0.2%). The effects would be concentrated in the electronic and electrical industries. However, if we look at value added exports from each country or region to the United States and China, we find that all except Japan are rapidly becoming more reliant on China. Taiwan leads with value added exports to China worth 13.4% of its GDP, followed by South Korea (7.5%), ASEAN (5.2%), and Japan (2.9%). If US-China trade friction escalates to Scenario 4 or beyond, all of these countries and regions would suffer even greater impacts from an economic slowdown in China.

Media reports about the impact of US-China trade friction appear to overestimate the effects due to a mood of fear engendered by uncertainty about the outcome of trade negotiations. Since lists of items targeted by USTR for the imposition of tariffs include few items from the textiles sector

or electronic and electrical industries, the impact on the United States and China themselves or on neighboring countries would be limited as long as the conflict remains at the Scenario 1 stage. However, the effects would immediately intensify if the situation escalates to Scenario 2, leading to conspicuous changes in the trade statistics of both China and its neighbors. To avoid falling prey to the impact of US-China trade friction, all concerned need to carry out careful and detailed analyses of the implications under these scenarios.

• **Column 1: Compilation Process for International Input-Output Tables**

TiVA statistics are based on international input-output tables, which are produced through matrix calculations using data aggregated by country and industry. These tables identify sources of value added in each country in the form of a matrix, as shown in Fig.1 of this column. The inputs required by industries in each country to produce goods and services are shown in vertical columns, while the outputs produced by those industries are shown on horizontal rows. Inputs are divided into intermediate inputs and added value, and outputs into intermediate demand and final demand.

We will now extract some specific figures from the Inter-Country Input-Output (ICIO) Tables compiled by the OECD. In 2015, automobile production in Thailand received inputs of $1,237.96 million from the Japanese automobile industry, and $230.68 million from machinery and equipment industries. These inputs are equivalent to 3.4% and 0.6% respectively of the production of the Thai automobile industry, which amounted to $36,633.8 million. These figures (0.034) and (0.006) are referred to in the input-output tables as "input coefficients". These input coefficients show the input units from the Japanese automobile industry and machinery and equipment industry that are needed by the Thai transportation equipment industry to produce one output unit.

Because TiVA statistics are gathered from 64 countries and regions and 36 industries, there are 64 × 36 columns for intermediate inputs, and 64 × 36 rows for intermediate demand. From the intersections between these rows and columns, we can obtain approximately 5.31 million input coefficients, which are equivalent to the products of both. In this way, we can identify inputs from 63 countries × 36 industries that are included in the value of production by the Thai automobile industry. This input matrix is known as an "international input-output matrix". It allows us to calculate amounts of value added trade by identifying sources of value added by country and industry.

Column Fig.1 Diagram of International Input-Output Table
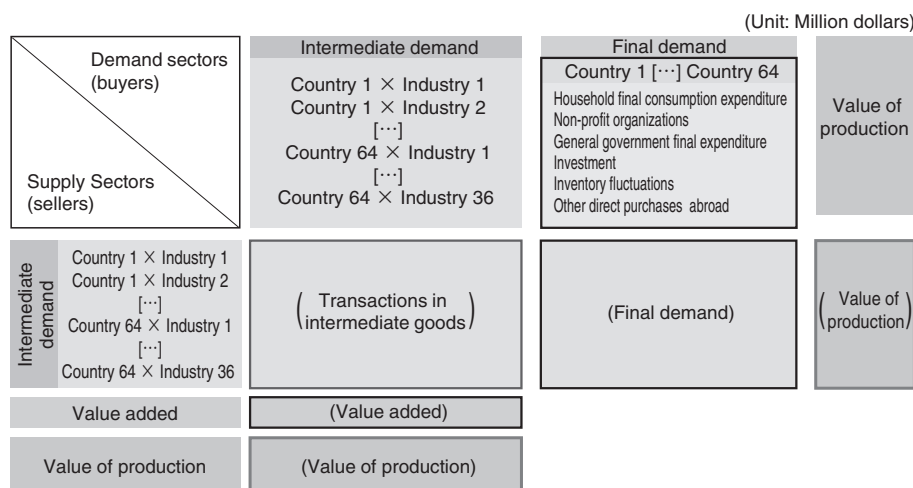
Source: Compiled by JRI using OECD data

• Column 2: Value Added trade statistics are estimates

International input-output table are based on national input-output tables and bilateral trade statistics. However, international input-output tables cannot be compiled simply by listing these statistics. For example, Thailand's input-output tables allow us to trace transactions within Thailand by determining the extent to which the transportation equipment industry procures intermediate goods from the machinery and equipment and electrical machinery industries. However, we cannot ascertain where those intermediate goods were made by tracing offshore transactions. Japan's trade statistics tell us about overseas transactions, allowing us to ascertain the amount of goods exported to Thailand by the machinery and equipment and electrical equipment industries, but they tell us nothing about domestic transactions, so we cannot determine what portion of those exports went to the Thai transportation equipment industry.

Two assumptions—the production assumption and the proportionality assumption—were introduced to overcome this problem (OECD [2013a, 2013b]). The production assumption is the assumption that companies used the same goods and services to produce the same products, while the proportionality assumption is the assumption that the percentage of intermediate goods procured overseas by a particular industry will be equal to the ratio of imports of domestic demand for the products concerned. By using these assumptions, we can estimate which industries in which countries are procuring intermediate goods from which industries in which countries. While these assumptions are admittedly essential for the purposes of simplification, there are aspects that diverge from reality, resulting in biases in estimation results.

For example, all companies are different. Even if they are in the same industry, they may produce different items or use different technologies to produce the same items. Clearly, these factors invalidate the production assumption. It is well established that highly productive companies will engage in exporting or establish overseas production facilities more aggressively than companies with low productivity, and that a higher proportion of their value added will be produced overseas. Because the production assumption ignores these differences between companies, it tends to underestimate the amount of value added produced overseas.

The proportionality assumption ignores the fact that the percentage of intermediate goods produced overseas will vary according to whether those goods will be used domestically or exported. In developed countries, there is little variation in procurement ratios according to the destination for goods, but in developing countries these ratios frequently vary according to whether goods are procured for exporting or domestic markets. This is apparent from the activities of Chinese smartphone manufacturers, which use substantial quantities of domestically produced parts supplied by Apple. If the percentages of goods procured for domestic use are calculated using the proportionality assumption and those ratios are applied across entire industries, the domestic value added included in China's smartphone exports will be overestimated.

End Notes

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