

# Intra-industry trade in the Japanese automobile sector

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## 1. Introduction

The automobile sector comprises approximately 20% of Japan's international trade in goods and remains a core sector of Japanese manufacturing. This research note builds on the author's previous work on Japanese automobile trade statistics and takes one step further. Specifically, the concept of intra-industry trade is applied to Japanese international trade in automobiles in an effort to better understand its characteristics and structure.

Intra-industry trade refers to the phenomenon of two-way trade in nearly identical or similar goods. In the case of automobiles, most countries that produce cars, including Japan, both export and import automobiles. Because its auto exports far exceed its auto imports, Japan's intra-industry trade in autos is rather limited. Nevertheless, considerable variation in the extent of Japan's intra-industry trade in autos has been seen over the past several decades. Since 1988, Japan's intra-industry trade share of its total car trade has fluctuated within a range of near zero to almost 25%.

This note is organized as follows: The next section reviews the concept of intra-industry trade and defines the intra-industry trade (IIT) index; Section 3 presents and analyzes the IIT indices of the Japanese automobile sector; Section 4 summarizes findings, presents several hypotheses regarding the underlying changes in Japan's intra-industry trade and proposes a future research agenda.

## 2. Intra-industry trade – a concept to analyze the structure of international trade

The pattern of trade—what countries export and import—can be explained by comparative advantage as theorized by early economists David Ricardo, Eli Heckscher and Bertil Ohlin. According to this traditional view of trade, countries should export those products that they are relatively good at producing and import other products. Countries thus either export or import particular goods. (The existence of trade costs leads to some goods not being traded, which means they must be produced domestically.) The sources of comparative advantage include such factors as international differences in technology and factor endowments. The larger the differences, the stronger the incentives for trade.

Squarely applied to automobiles, then, countries exporting cars should not be importing cars, and vice versa. In reality, however, car-producing countries not only export but also import cars from other countries. By the second half of the twentieth century, the phenomenon of such two-way trade in the same product categories came to be recognized by researchers. Grubel and Lloyd (1975), among others, called the phenomenon ‘intra-industry’ trade, as opposed to ‘inter-industry’ trade based on comparative advantage. In contrast to inter-industry trade, it was found that intra-industry trade typically takes place between industrialized countries with similar technology and/or factor endowments. To measure the level of a country’s intra-industry trade, Grubel and Lloyd (1975) devised a simple and useful method known as the intra-industry index, or IIT index.

The IIT index calculation is straightforward. Denoting country  $j$ ’s export to country  $k$  in industry (or product category)  $i$  as  $X_{jk}^i$ , and country  $j$ ’s import from country  $k$  in industry  $i$  as  $M_{jk}^i$ , the intra-industry trade index is calculated by the following formula:

$$IIT_{jk}^i \equiv 1 - \frac{|X_{jk}^i - M_{jk}^i|}{X_{jk}^i + M_{jk}^i} = 2 \cdot \frac{\min(X_{jk}^i, M_{jk}^i)}{X_{jk}^i + M_{jk}^i}$$

The index conveniently takes on values from 0 to 1. The closer its value is to one, the more significant is intra-industry trade. In the extreme, if exports match imports exactly, the index has a value of one. On the other hand, if trade is one-sided, that is, if a country only exports or only imports the product, the IIT index is zero.

## 3. Measuring the IIT indices of Japanese automobile trade

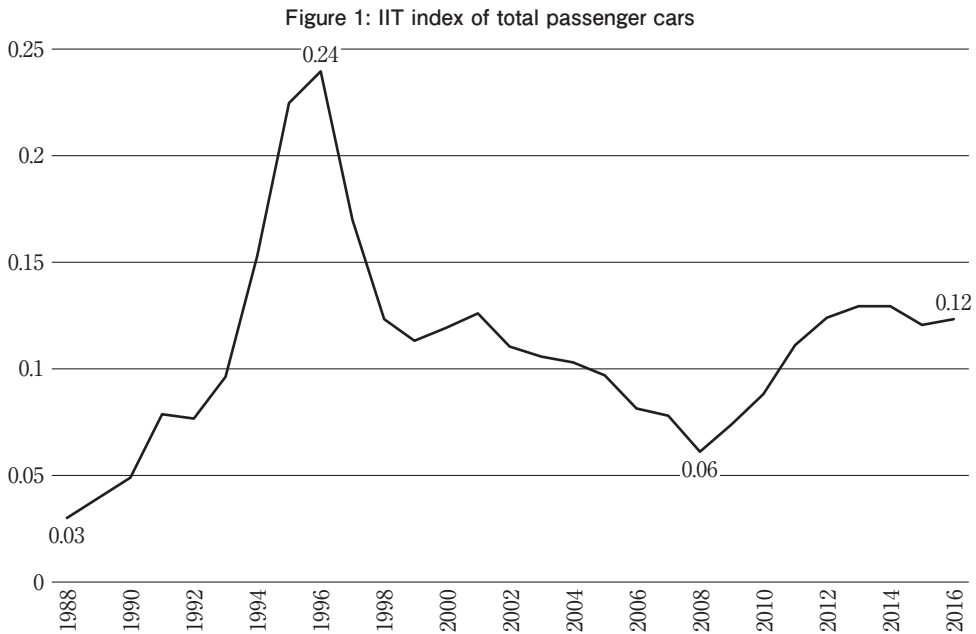
### 3.1 Overall

In the discussion that follows, relevant trade statistics are used to calculate the IIT index of the Japanese automobile sector. Here,  $i$  indicates the automobile industry (new cars),  $j$  indicates Ja-

pan, and  $k$  indicates the rest of the world. (Alternatively,  $k$  can designate a specific country; however, this note focuses on Japan's trade with the rest of the world.)

The export and import data are taken from the Trade Statistics of Japan issued by the Ministry of Finance (MOF) and available electronically from 1988. The MOF data are presented both in value and volume terms; volume, in this case, is units or numbers of cars. Export values are based on the free on board (FOB) price; import values are based on cost, insurance, and freight (CIF) price. This means that, on top of the FOB price, the CIF price includes trade costs for freight and insurance. Other things being equal, the CIF price tends to be higher than the FOB price. As a result, value data tends to overvalue imports relative to exports, which would lead to inaccuracies in the IIT index calculation. (In the case of Japanese autos, because exports exceed imports, using value data tends to narrow the export-import gap and generate higher IIT indices.) For this reason, volume data, that is, units or numbers of exported and imported cars, are used to calculate the IIT index. (The downside of using volume data is that it neglects unit price differentials. Alternatively, one can use data on exports from the rest of the world to Japan rather than using the import data of Japan.)

Figure 1 shows the IIT index for Japan's total passenger car trade with the rest of the world from 1988 to 2016. (Complete data are provided in the Appendix.) As is widely known, Japan's exports well exceed imports in its automobile trade. Therefore, understandably, the IIT index has, on the whole, not been high. In fact, it has not exceeded 0.25 during the past several decades. In 1988,



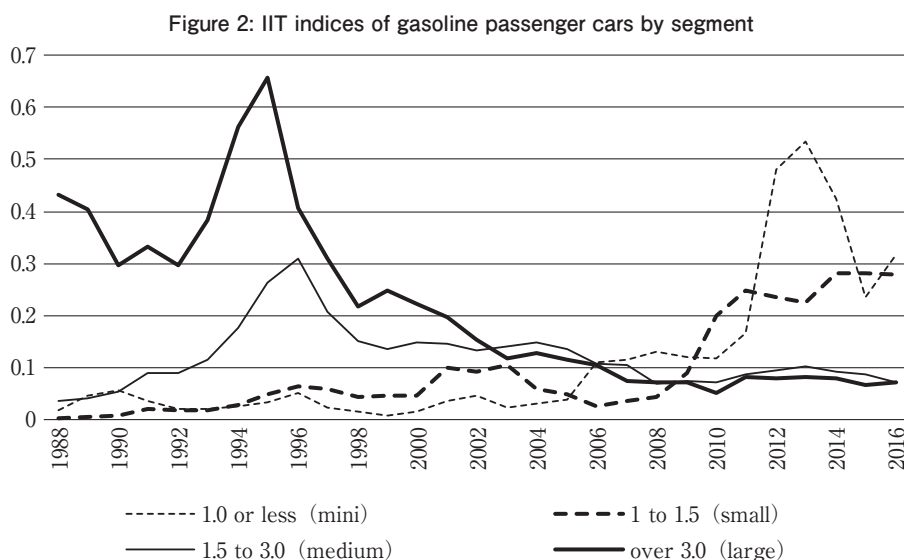
Source: Graph created by author using data from MOF trade statistics.

the IIT index was 0.03. The index rose markedly during the first half of the 1990s. However, after recording its peak of 0.24 in 1996, it declined sharply. It then began a gradual descent until reaching a bottom of 0.06 in 2008. The index increased rather steadily after 2008, settling at 0.12 in 2016. This means that in 2016, slightly more than 10% of Japan's passenger car trade was intra-industry trade. (If the value-based trade data are used for the calculation, the 2016 IIT index would be 0.20.)

### 3.2 IIT indices by car segment

The results described above indicate that the IIT index for automobiles fluctuated within a range of 0.03 to 0.24 during the roughly 30-year span of the study. Breaking down these yearly indices by passenger car category or segment should enable us to better understand the background of these fluctuations. (The focus here is on gasoline cars, since they accounted for 92% of Japan's passenger car trade in 2016, the most recent year for which we have data.) In the MOF statistics used in the study, cars are categorized by engine displacement into four segments: cars with 1.0 liter or smaller engines (hereafter labeled the mini segment), cars with engines exceeding 1.0 but not exceeding 1.5 liters (small segment), cars with engines exceeding 1.5 but not exceeding 3.0 liters (medium segment), and cars with engines exceeding 3.0 liters (large segment). Figure 2 shows the IIT indices for each of these segments.

The IIT index values for the mini segment were among the lowest of the four segments but began to increase around 2005. The index showed a sharp rise in 2012, from 0.165 in 2011 to 0.481. By 2016, the mini segment index had become the highest among the four segments, with an IIT index of 0.317.



Source: Graph created by author using data from MOF trade statistics.

A trend similar to the mini segment can be seen in the small segment. Although this segment had the lowest IIT index (close to zero, at 0.00394) in 1988, its index began increasing from around 2009. It jumped to 0.201 in 2010 and remained the highest or second highest of the four indices in subsequent years. Its value in 2016 was 0.280.

The medium segment index climbed to 0.310 in 1996 but then gradually declined, taking on values of roughly 0.1 or less during the last decade or so. In 2016, the index was 0.0707.

The trend of the IIT index for the large segment is similar to that of the medium segment. It reached 0.658 in 1995, but then declined sharply in the late 1990s. Throughout the last decade, it has been less than 0.1. In 2016, its value was 0.0718, which is very close to the index value of the medium segment.

Overall, Figure 2 indicates that there are significant variations among segments and suggests that the main segments contributing to intra-industry trade in the Japanese automobile sector have shifted from the larger segments to the smaller segments.

### 3.3 Comparison of the IIT indices by segment, selected years

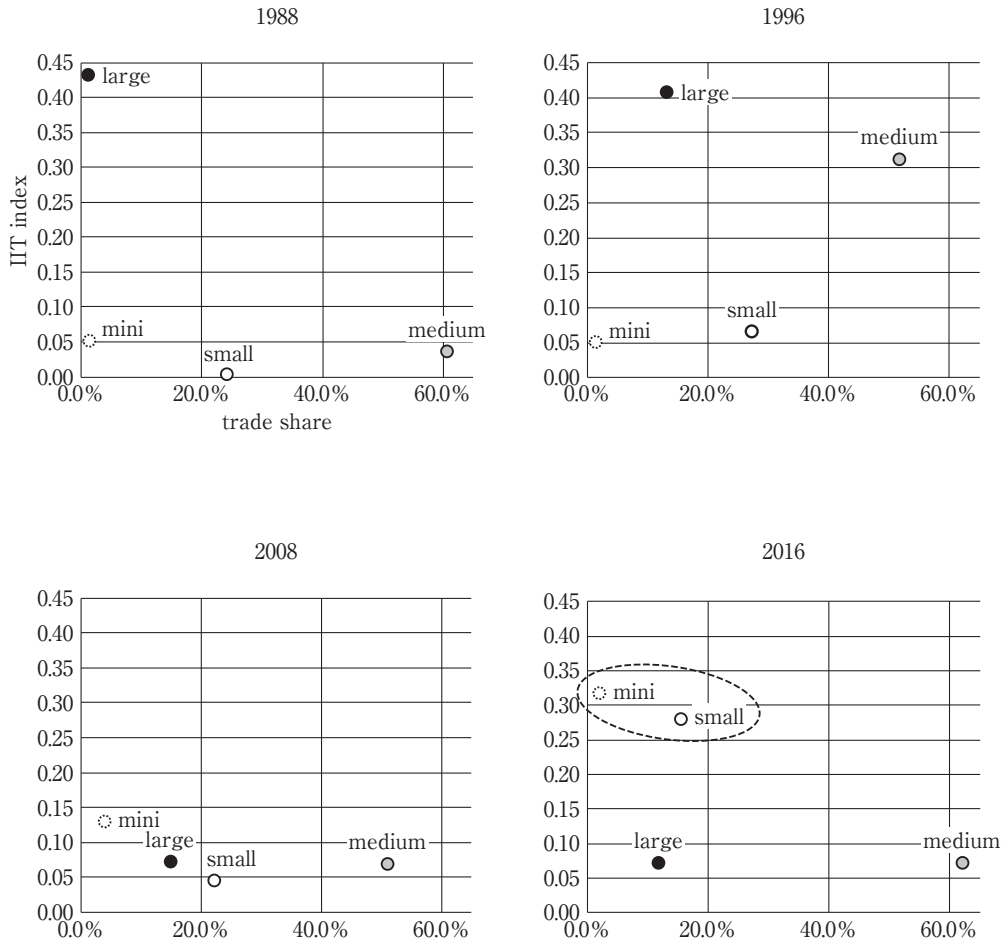
Figure 2 shows pronounced changes in the trends of the IIT indices in the mid-1990s and after 2008. Figure 3 provides the means to look more closely at these changes. In the panels of the figure, the positions of the four segments with respect to trade share and IIT index are plotted for the years 1988, 1996, 2008 and the most recent year, 2016. This format gives us a useful tool to analyze the relative importance of each segment in Japan's intra-industry auto trade.

In comparing the 1988 and 1996 data, little change can be seen in the position of the mini segment, while the small segment shows some increase in the level of the IIT index. The trade share of the large segment, which has the highest IIT index, also increased over this period. The greatest change, however, is found in the medium segment, where the IIT index rose from 0.035 in 1988 to 0.310 in 1996. Moreover, this segment had the largest share of the Japanese passenger car trade. The increase in the mid-1990s, therefore, can be attributed to the increase in intra-industry trade in medium and large cars. The momentum, however, did not last.

The 2008 data shows that the IIT index values for the medium and large segments fell dramatically relative to 1996 levels. This, then, is the reason for the decline in the overall level of the IIT index from the mid-1990s that was described in Figure 1.

Comparing the 2008 and 2016 data, there are few changes in the relative positions of the medium and large segments. The medium segment had the highest trade share in both years, and its IIT index remained nearly the same. Similarly, the trade share of the large segment and its IIT index showed no significant change. It seems clear, then, that the increase in the overall level of the IIT index in the most recent decade is due to the increased intra-industry trade in the mini and small seg-

Figure 3. IIT index and trade share by segment, selected years



Note: Data for gasoline cars only.

Source: Graph created by author using data from MOF trade statistics.

ments.

#### 4. Tentative summary of findings, hypotheses and future research agenda

##### Findings

- The overall level of the calculated IIT indices for the Japanese automobile sector is low. During the period from 1988 to 2016, the IIT index of Japan's passenger car trade remained in the range of 0.03 to 0.25. (Value-based IIT indices tend to be higher.)
- Some increases in IIT were seen in the mid-1990s and in the most recent decade.
- The increase in the mid-1990s was attributable to the increase in the intra-industry trade in medium- and large-sized cars, the momentum of which did not last.

### Intra-industry trade in the Japanese automobile sector

- The increase in the most recent decade was due to increased intra-industry trade in the smaller segments, namely the mini segment and the small segment.

#### *Interpretation and hypotheses on the background of the findings*

- The low level of the IIT indices can simply be interpreted as a sign of Japan having comparative advantage in automobiles. Therefore, as a whole, Japan's automobile trade is inter-industry rather than intra-industry.
- However, as indicated in the data, there is some two-way trade in automobiles, which is difficult to explain solely by comparative advantage.
- Product differentiation is perhaps important in automobiles: Manufacturers produce quite similar but differentiated products, and consumers have a taste for variety. Some consumers will purchase imported cars even if similar cars are produced and sold domestically. Therefore, it is natural that some intra-industry trade is observed in this sector.
- The prime source of Japanese automobile imports is Germany, along with other countries in Europe. Although the value of the IIT index is generally low, the extent of Japan's intra-industry trade in automobiles seems to be affected by imports from Europe.
- Imports from the U.S. temporarily increased in the mid-1990s. One reason might be that most Japanese car manufacturers built their transplants in the U.S. during the 1980s, amidst U.S.-Japan trade frictions. By the mid-1990s, some of the made-in-America cars produced by these transplants began to be exported to Japan. This may explain the temporary increase in the IIT indices in the mid-1990s.
- The data showed that intra-industry trade in the smaller-car segments has been increasing in recent years. This likely reflects changes on the supply side: European manufactures now offer smaller and more affordable cars for Japanese consumers, which is likely to have increased the IIT indices in the mini and small segments.

#### *Research agenda*

- A large portion of the cars imported to Japan come from Germany. It would therefore be useful to look into Japan's bilateral trade in automobiles with Germany and other car-producing countries in Europe.
- The bilateral trade of the U.S. and Japan also needs to be examined. In particular, it would be of interest to study why the increase in U.S. car exports to Japan in the mid-1990s did not last.
- Some cars are now being imported from other parts of Asia; for example, from Thailand. As car imports from Thailand were preceded by motorcycle imports, it would be of interest to consider whether cars follow the pattern of motorcycles, in which case Japanese intra-industry trade in au-

Appendix: Trade volume based IIT indices of Japan's automobile trade

year	gasoline				diesel			others	overall
	1.0 or less	1 to 1.5	1.5 to 3.0	over 3.0	1.5 or less	1.5 to 2.5	over 2.5		
1988	0.01950	0.00394	0.03515	0.43125	0.00063	0.01644	0.00784	0.00898	0.03027
1989	0.04613	0.00549	0.04206	0.40368	0.00303	0.01547	0.01003	0.00681	0.03928
1990	0.05609	0.00791	0.05322	0.29766	0.00040	0.01750	0.00944	0.05053	0.04910
1991	0.03687	0.02026	0.08960	0.33137	0.00476	0.03377	0.01377	0.37861	0.07869
1992	0.02103	0.01799	0.09104	0.29716	0.00114	0.00886	0.00986	0.12427	0.07667
1993	0.02178	0.01765	0.11415	0.38281	0.00103	0.00835	0.00820	0.30235	0.09636
1994	0.02662	0.02752	0.17714	0.56177	0.00384	0.01949	0.21195	0.52465	0.15277
1995	0.03492	0.04951	0.26291	0.65787	0.01132	0.02498	0.31999	0.62866	0.22436
1996	0.05091	0.06538	0.31045	0.40661	0.00596	0.03715	0.17532	0.73155	0.23946
1997	0.02302	0.05881	0.20661	0.30978	0.00499	0.03726	0.07853	0.89203	0.16985
1998	0.01574	0.04449	0.14997	0.21822	0.00102	0.00891	0.09129	0.86498	0.12302
1999	0.00816	0.04591	0.13575	0.24784	0.01047	0.00147	0.01046	0.13480	0.11303
2000	0.01659	0.04534	0.14929	0.22139	0.00739	0.00344	0.03809	0.00823	0.11915
2001	0.03663	0.10119	0.14590	0.19712	0.00242	0.00391	0.01137	0.11735	0.12605
2002	0.04572	0.09148	0.13359	0.15325	0.00165	0.00457	0.00429	0.07493	0.11058
2003	0.02359	0.10553	0.13970	0.11703	0.00340	0.00292	0.00154	0.00215	0.10568
2004	0.03078	0.05892	0.14771	0.12923	0.00180	0.00310	0.00199	0.00392	0.10291
2005	0.03993	0.04959	0.13589	0.11629	0.00420	0.00224	0.00187	0.01095	0.09668
2006	0.11116	0.02539	0.10693	0.10638	0.00891	0.00213	0.00934	0.13035	0.08161
2007	0.11434	0.03500	0.10564	0.07443	0.01919	0.00272	0.01365	0.02672	0.07803
2008	0.12944	0.04358	0.06836	0.07090	0.00823	0.00284	0.01515	0.04292	0.06105
2009	0.11937	0.09062	0.07461	0.07253	0.00478	0.00408	0.00427	0.20223	0.07414
2010	0.11781	0.20081	0.07313	0.05233	0.00735	0.00219	0.03551	0.10641	0.08806
2011	0.16524	0.24847	0.08721	0.08128	0.01019	0.00395	0.02520	0.02776	0.11120
2012	0.48081	0.23480	0.09594	0.08023	0.02900	0.05381	0.03286	0.02992	0.12402
2013	0.53331	0.22483	0.10341	0.08260	0.10222	0.11679	0.04282	0.24735	0.12909
2014	0.42552	0.28160	0.09293	0.07888	0.44051	0.12364	0.06150	0.72440	0.12942
2015	0.23448	0.28016	0.08621	0.06687	0.03876	0.17981	0.07331	0.44034	0.12093
2016	0.31678	0.27966	0.07070	0.07182	0.38569	0.31805	0.09314	0.16581	0.12331

Source: Calculated by author using MOF trade statistics.

tomobiles could grow much larger.

- The pattern of Japan's international trade would also be affected by the production strategies of Japanese manufacturers, particularly in the long-run. That is, whether these manufacturers stay in Japan and maintain current levels of production and exports would obviously affect the pattern and structure of automobile trade. Such corporate strategies are important issues in their own right but are difficult to predict.

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#### References

- Grubel, Herbert G., and P.J. Lloyd. 1975. *Intra-industry trade: the theory and measurement of international trade in differentiated products*. Macmillan.
- Ministry of Finance. various years. *Trade statistics of Japan*. Available in electronic format from [http://www.customs.go.jp/toukei/info/index\\_e.htm](http://www.customs.go.jp/toukei/info/index_e.htm)