
Changes in the Auto Parts Global Value Chain between 2000 and 2018

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Abstract:

This study investigates the changes in the auto parts manufacturing global value chain (GVC) between 2000 and 2018. This study examines general and key automobile parts comprising gasoline engines, diesel engines, and engine parts.

We created four groups for analysis: “Emerging,” “Remaining,” “Moderate Change,” and “Declining” according to the degree of changes between 2000 and 2018. To distinguish further, “Big”, “Semi-Big”, “Hopes” and “Newcomers” are defined.

In several items, the same countries appear under Big, such as the US, Germany, Mexico, Japan, Canada, or the UK. Semi-Big countries are those such as France, Italy, Spain, South Korea, Austria, and so on. In several items, China appears under Hopes. Under the Newcomers, some countries appear in several items such as Thailand, India, Romania, Czechia, and Singapore etc.

1. Introduction

In the automobile industry, auto parts and components are important both for production and R&D (Baba 2013, 2016; Fujimoto 2013). Without well-designed auto parts, cars could fail to meet customer expectations of shape, performance, and durability. Similarly, without strong auto parts manufacturers, with the ability to produce trial auto parts for car designers during R&D, the industry could find it difficult to improve new automobiles or complete new designs quickly.

In the past, it has been common for automobile manufacturers to procure auto parts and components in domestic locally. Sometimes they have just exported auto parts for their foreign subsidiaries in CKD production. Today, the globalization of the industry has changed this simple structure to complexity. This study investigates the changes in the auto parts manufacturing global value chain (GVC) between 2000 and 2018. For this, we examine general and key automobile parts comprising gasoline engines, diesel engines, and engine parts.

2. Data and Method

To analyze the GVC, this study uses trade statistics from the Harmonized Commodity Description and Coding System (HS); specifically, codes HS8708, HS8407, HS8408, and HS8409.

HS8407 is the code for gasoline engines, one of the most important, key components for car production. HS8408 is the code for diesel engines. HS8409 is the code for engine parts. Codes HS8407 to HS8409 are designated for car manufacturing and for other usage; the so called “product mix.” We select these for analysis based on the following: 1. we can get a rough view of the industry as many of these parts are used in automobiles, 2. From the viewpoint of supporting industries in the GVC, trading in “engines” offers meaningful analysis, and 3. we can collect data on higher value added car parts by investigating HS8708.

Although we were interested in including newer engines, such as hybrid engines or fuel cell engines, we were unable to find suitable HS codes for these. Thus, a study of these new type of engines should be done in the future.

HS8708 is a representative code for general auto parts. It includes items such as bumpers, seat belts, body parts, brakes, gear boxes, driving-axles, wheels, suspensions, radiators, exhaust pipes, clutches, steering wheels, airbags, and other miscellaneous parts. Parts included in HS8708 are essential key components for car manufacturing.

For our analysis, we extract the raw data from the UN Comtrade Database. In

this study, we examine data from 2000 to 2018. To compare trade values in these different years, we use a 2018 deflator calculated according to the U.S. Consumer Price Index (CPI) extracted from the World Bank Open Data Base. The deflator of 1.4582 is used to convert the 2000 price to the 2018 price. Automobile production data are from International Organization of Motor Vehicle Manufacturers (OICA).

2. The GVC in 2018

2.1 Auto Parts Overview

(1) Overview

In 2018, there were 130 countries taking part in the GVC for general car parts (HS8708). The total trade value, which is a sum of export values and import values, was 828.7 billion US dollars. The top 10 countries represented 65% of this market ranked as follows: the US, Germany, China, Mexico, Japan, France, Canada, Spain, Czechia, and Italy. The top five represented 48% market share and the top 20 represented 85%. In detail, the total trade values and shares of the top five were as follows: The US at \$117.1 billion (14.1%), Germany at \$112.0 billion (13.5%), China at \$64.2 billion (7.7%), Mexico at \$57.0 billion (6.9%), and Japan at \$44.8 billion (5.4%).

(2) Supply side of GVC auto parts

In 2018, there were 126 countries taking part in exporting car parts. The total export value that year was 414.3 billion US dollars. The top 10 countries represented 71% of the market ranked as follows: Germany, the US, Japan, China, Mexico, South Korea, Czechia, France, Italy, and Poland. The top five represented 52% market share and the top 20 represented 90%. In detail, total trade values and shares of the top five were as follows: Germany at \$67.6 billion (16.3%), the US at \$45.7 billion (11.0%), Japan at \$35.9 billion (8.7%), China at \$34.9 billion (8.4%), and Mexico at \$29.7 billion (7.2%).

(3) Demand side of GVC auto parts

In 2018, there were 130 countries taking part in importing car parts. The total import value that year was 414.4 billion US dollars. The top 10 countries represented 64% of the market ranked as follows: the US, Germany, China, Mexico, Canada, Spain, France, the UK, Czechia, and Slovakia. The top five represented 47% market share and the top 20 represented 83%. In detail, total trade values and shares of the top five were as follows: the US at \$71.4 billion (17.2%), Germany at \$44.4 billion (10.7%), China at \$29.3 billion (7.1%), Mexico at \$27.3 billion (6.6%), and Canada at \$20.2 billion (4.9%).

2.2 Gasoline Engines

(1) Overview

In 2018, there were 136 countries taking part in the GVC for gasoline engines (HS8407). The total trade value, which is a sum of export values and import values, was 104.0 billion US dollars. The top 10 countries represented 67% of the market ranked as follows: the US, Germany, Japan, Mexico, Canada, China, Hungary, France, Spain, and Thailand. The top five represented 48% market share and the top 20 represented 86%. In detail, total trade values and the shares of the top five were as follows: the US at \$18.9 billion (18.2%), Germany at \$9.4 billion (9.0%), Japan at \$7.9 billion (7.6%), Mexico at \$7.1 billion (6.8%), and Canada at \$6.9 billion (6.7%).

(2) Supply side of GVC gasoline engines

In 2018, there were 125 countries taking part in exporting gasoline engines. The total export value was 54.1 billion US dollars. The top 10 countries represented 73% of the market ranked as follows: Japan, the US, Germany, Hungary, Mexico, China, Canada, Austria, Thailand, and France. The top five represented 50% market share and the top 20 represented 93%. In detail, total trade values and the shares of the top five were as follows: Japan at \$7.0 billion (13.0%), the US at \$6.9 billion (12.8%), Germany at \$5.2 billion (9.7%), Hungary at \$4.0 billion (7.3%), and Mexico at \$3.9 billion (7.2%).

(3) Demand side of GVC gasoline engines

In 2018, there were 136 countries taking part in importing gasoline engines. The total import value was 49.9 billion US dollars. The top 10 countries represented 67% of the market ranked as follows: the US, Canada, Germany, Mexico, China, Spain, Czechia, Slovakia, Russia, and Turkey. The top five represented 53% market share and the top 20 represented 83%. In detail, total trade values and the shares of the top five were as follows: the US at \$12.0 billion (24.0%), Canada at \$4.5 billion (9.1%), Germany at \$4.2 billion (8.3%), Mexico at \$3.2 billion (6.4%), and China at \$2.7 billion (5.3%).

2.3 Diesel Engines

(1) Overview

In 2018, there were 136 countries taking part in the GVC for diesel engines (HS8408). The total trade value, which is a sum of export values and import values, was 99.9 billion US dollars. The top 10 countries represented 67% of the market ranked as follows: the US, Germany, Mexico, the UK, Japan, France, China, Italy, Spain, and

Austria. The top five represented 46% market share and the top 20 represented 88%. In detail, total trade values and the shares of the top five were as follows: the US at \$14.5 billion (14.5%), Germany at \$11.7 billion (11.7%), Mexico at \$7.6 billion (7.6%), the UK at \$6.4 billion (6.4%), and Japan at \$5.6 billion (5.6%).

(2) Supply side of GVC diesel engines

In 2018, there were 123 countries taking part in exporting diesel engines. The total export value was 50.6 billion US dollars. The top 10 countries represented 77% of the market ranked as follows: the US, Germany, Japan, the UK, France, Italy, Sweden, Austria, Hungary, and Poland. The top five represented 53% market share and the top 20 represented 96%. In detail, total trade values and the shares of the top five were as follows: the US at \$7.7 billion (15.2%), Germany at \$7.1 billion (14.1%), Japan at \$4.7 billion (9.2%), the UK at \$4.5 billion (8.9%), and France at \$3.0 billion (5.9%).

(3) Demand side of GVC diesel engines

In 2018, there were 136 countries taking part in importing diesel engines. The total import value was 49.3 billion US dollars. The top 10 countries represented 65% of the market ranked as follows: the US, Mexico, Germany, China, Spain, Turkey, the UK, France, Italy, and Czechia. The top five represented 46% market share and the top 20 represented 83%. In detail, total trade values and the shares of the top five were as follows: the US at \$6.8 billion (13.8%), Mexico at \$4.7 billion (11.5%), Germany at \$4.6 billion (9.3%), China at \$3.2 billion (6.5%), and Spain at \$2.4 billion (4.9%).

2.4 Engine Parts

(1) Overview

In 2018, there were 136 countries taking part in the GVC for engine parts (HS8409). The total trade value, which is a sum of export values and import values, was 138.8 billion US dollars. The top 10 countries represented 64% of the market ranked as follows: Germany, the US, China, Japan, Mexico, the UK, France, Italy, South Korea, and Poland. The top five represented 47% market share and the top 20 represented 85%. In detail, total trade values and the shares of the top five were as follows: Germany at \$21.4 billion (15.4%), the US at \$16.3 billion (11.8%), China at \$10.0 billion (7.2%), Japan at \$9.0 billion (6.5%), and Mexico at \$8.4 billion (6.1%).

(2) Supply side of GVC engine parts

In 2018, there were 125 countries taking part in exporting engine parts. The

total export value was 70.5 billion US dollars. The top 10 countries represented 70% of the market ranked as follows: Germany, Japan, the US, China, Mexico, South Korea, Italy, France, Poland, and the UK. The top five represented 54% market share and the top 20 represented 89%. In detail, total trade values and the shares of the top five were as follows: Germany at \$14.1 billion (20.0%), Japan at \$7.0 billion (10.0%), the US at \$6.3 billion (9.0%), China at \$6.0 billion (8.5%), and Mexico at \$4.5 billion (6.3%).

(3) Demand side of GVC engine parts

In 2018, there were 136 countries taking part in importing engine parts. The total import value was 68.3 billion US dollars. The top 10 countries represented 61% of the market ranked as follows: the US, Germany, the UK, China, Mexico, France, Hungary, Italy, Canada, and Austria. The top five represented 44% market share and the top 20 represented 82%. In detail, total trade values and the shares of the top five were as follows: the US at \$10.0 billion (14.7%), Germany at \$7.3 billion (10.6%), UK at \$4.4 billion (6.5%), China at \$4.1 billion (5.9%), and Mexico at \$4.0 billion (5.8%).

3. The GVC in 2000

3.1 Auto Parts Overview

(1) Overview

In 2000, there were 161 countries taking part in the GVC for general car parts (HS8708). The total trade value, which is a sum of export values and import values, was 86.9 billion US dollars. The top 10 countries represented 79% of the market ranked as follows: the US, Canada, Germany, Japan, France, the UK, Mexico, Spain, Italy, and Belgium. The top five represented 55% market share and the top 20 represented 91%. In detail, total trade values and the shares of the top five were as follows: the US at \$86.9 billion (21.6%), Canada at \$42.2 billion (10.5%), Germany at \$36.0 billion (8.9%), Japan at \$28.1 billion (7.0%), and France at \$26.9 billion (6.7%).

(2) Supply side of GVC auto parts

In 2000, there were 154 countries taking part in exporting car parts. The total export value was 201.8 billion US dollars. The top 10 countries represented 84% of the market ranked as follows: the US, Japan, Germany, France, Canada, the UK, Italy, Mexico, Spain, and Belgium. The top five represented 63% market share and the top 20 represented 94%. In detail, total trade values and the shares of the top five were as follows: the US at \$46.2 billion (22.9%), Japan at \$25.1 billion (12.4%), Germany at \$22.1 billion (11.0%), France at \$17.5 billion (8.7%), and Canada at \$15.4 billion (7.6%).

(3) Demand side of GVC auto parts

In 2000, there were 161 countries taking part in importing car parts. The total import value was 201.5 billion US dollars. The top 10 countries represented 75% of the market ranked as follows: the US, Canada, Mexico, Spain, Germany, the UK, France, Belgium, Italy, and Sweden. The top five represented 55% market share and the top 20 represented 88%. In detail, total trade values and the shares of the top five were as follows: the US at \$40.7 billion (20.2%), Canada at \$26.9 billion (13.3%), Mexico at \$14.9 billion (7.4%), Spain at \$14.4 billion (7.2%), and Germany at \$13.9 billion (6.9%).

3.2 Gasoline Engines

(1) Overview

In 2000, there were 165 countries taking part in the GVC for gasoline engines (HS8407). The total trade value, which is a sum of export values and import values, was 81.6 billion US dollars. The top 10 countries represented 84% of the market ranked as follows: the US, Canada, Japan, Germany, Mexico, Spain, Hungary, the UK, Belgium, and France. The top five represented 67% market share and the top 20 represented 95%. In detail, total trade values and the shares of the top five were as follows: the US at \$22.8 billion (28.0%), Canada at \$11.4 billion (14.0%), Japan at \$8.1 billion (9.9%), Germany at \$7.7 billion (9.4%), and Mexico at \$4.9 billion (6.0%).

(2) Supply side of GVC gasoline engines

In 2000, there were 140 countries taking part in exporting gasoline engines. The total export value was 39.2 billion US dollars. The top 10 countries represented 91% of the market ranked as follows: the US, Japan, Canada, Hungary, Germany, Mexico, Austria, the UK, Spain, and France. The top five represented 69% market share and the top 20 represented 99%. In detail, total trade values and the shares of the top five were as follows: the US at \$9.6 billion (24.4%), Japan at \$7.5 billion (19.1%), Canada at \$4.1 billion (10.5%), Hungary at \$3.0 billion (7.5%), and Germany at \$2.8 billion (7.1%).

(3) Demand side of GVC gasoline engines

In 2000, there were 165 countries taking part in importing gasoline engines. The total import value was 42.4 billion US dollars. The top 10 countries represented 83% of the market ranked as follows: the US, Canada, Germany, Mexico, Belgium, Spain, France, the UK, Italy, and Japan. The top five represented 70% market share and the top 20 represented 92%. In detail, total trade values and the shares of the top five were

as follows: the US at \$13.3 billion (31.3%), Canada at \$7.3 billion (17.3%), Germany at \$4.9 billion (11.6%), Mexico at \$2.1 billion (5.0%), and Belgium at \$1.9 billion (4.4%).

3.3 Diesel Engines

(1) Overview

In 2000, there were 165 countries taking part in the GVC for diesel engines (HS8408). The total trade value, which is a sum of export values and import values, was 46.5 billion US dollars. The top 10 countries represented 70% of the market ranked as follows: Germany, the US, France, the UK, Japan, Mexico, Belgium, Italy, Poland, and Canada. The top five represented 49% market share and the top 20 represented 89%. In detail, total trade values and the shares of the top five were as follows; Germany at \$6.5 billion (13.9%), the US at \$6.0 billion (13.0%), France at \$3.7 billion (7.9%), the UK at \$3.6 billion (7.7%), and Japan at \$3.1 billion (6.6%).

(2) Supply side of GVC diesel engines

In 2000, there were 145 countries taking part in exporting diesel engines. The total export value was 24.2 billion US dollars. The top 10 countries represented 86% of the market ranked as follows: Germany, the US, Japan, France, the UK, Poland, Sweden, Italy, Austria, and Hungary. The top five represented 63% market share and the top 20 represented 96%. In detail, total trade values and the shares of the top five were as follows: Germany at \$3.9 billion (16.1%), the US at \$3.8 billion (15.7%), Japan at \$2.9 billion (11.9%), France at \$2.5 billion (10.1%), and the UK at \$2.3 billion (9.5%).

(3) Demand side of GVC diesel engines

In 2000, there were 165 countries taking part in importing diesel engines. The total import value was 22.4 billion US dollars. The top 10 countries represented 68% of the market ranked as follows: Germany, the US, Belgium, Mexico, Canada, the UK, Spain, France, Italy, and Turkey. The top five represented 44% market share and the top 20 represented 85%. In detail, total trade values and the shares of each of the top five were as follows: Germany at \$2.6 billion (11.5%), the US at \$2.2 billion (10.0%), Belgium at \$1.8 billion (8.1%), Mexico at \$1.8 billion (7.9%), and Canada at \$1.5 billion (6.7%).

3.4 Engine Parts

(1) Overview

In 2000, there were 164 countries taking part in the GVC of engine parts (HS8409). The total trade value, which is a sum of export values and import values, was

75.3 billion US dollars. The top 10 countries represented 73% of the market ranked as follows: the US, Germany, Japan, Canada, Mexico, France, the UK, Italy, Hungary, and Austria. The top five represented 54% market share and the top 20 represented 88%. In detail, the total trade values and shares of each of the top five were as follows: the US at \$14.2 billion (18.9%), Germany at \$9.3 billion (12.4%), Japan at \$7.5 billion (10.0%), Canada at \$5.3 billion (7.1%), and Mexico at \$3.9 billion (5.2%).

(2) Supply side of GVC engine parts

In 2000, there were 141 countries taking part in export of engine parts. The total export value was 37.8 billion US dollars. The top 10 countries represented 81% of the market ranked as follows: Japan, the US, Germany, Mexico, Canada, France, the UK, Italy, Brazil, and Austria. The top five represented 64% market share and the top 20 represented 92%. In detail, total trade values and the shares of the top five were as follows: Japan at \$6.9 billion (18.3%), the US at \$6.9 billion (18.1%), Germany at \$6.4 billion (16.8%), Mexico at \$2.0 billion (5.3%), and Canada at \$1.8 billion (4.9%).

(3) Demand side of GVC engine parts

In 2000, there were 164 countries taking part in import of engine parts in 2000. Total import value was 37.5 billion US dollars. The top 10 countries represented 67% of the market ranked as follows: the US, Canada, Germany, France, the UK, Mexico, Hungary, Italy, Austria, and Sweden. The top five represented 48% market share and the top 20 represented 84%. In detail, total trade values and the shares of the top five were as follows: the US at \$7.4 billion (19.7%), Canada at \$3.5 billion (9.3%), Germany at \$2.9 billion (7.8%), France at \$2.1 billion (5.7%), and UK at \$2.1 billion (5.7%).

4. What changed between 2000 and 2018?

4.1 Trade Amount and Automobile Production

Table 1 presents the trade values for exports and imports each year for automobile parts production. Table 2 presents the magnitude of the changes in values between 2000 and 2018. As shown, automobile trade moved from 58.4 million units in 2000 to 95.6 million units in 2018, multiplying by 1.6 during this timeframe. The growth in the items investigated was as follows: auto parts multiplied by 2.1; gasoline engines multiplied by 1.3; diesel engines multiplied by 2.1; and engine parts multiplied by 1.8.

Regarding auto parts and engine parts, the growth rates were higher than that for car production. During this timeframe, automobiles became more complex. Moreover, although the number of auto parts to produce one car may have dropped because of

modularization or integration, the price for each item may have increased. The growth in diesel engines was also higher than that in car production. This could be due to demand for the product mix that includes diesel engines.

Table 1 Trade amount and car production (unit: billion USD in 2018 prices, million units)

	2000			2018		
	Exports	Imports	Total	Exports	Imports	Total
Auto Parts	201.8	201.5	403.3	414.3	414.4	828.7
Gasoline Engines	39.2	42.4	81.6	54.1	49.9	104.0
Diesel Engines	24.2	22.4	46.5	50.6	49.3	99.9
Engine Parts	37.8	37.5	75.3	70.5	68.3	138.8
Car production	58.4			95.6		

Source: Author

Table 2. Changes between 2000 and 2018 (magnitude of growth)

	Exports	Imports	Total
Auto Parts	2.1	2.1	2.1
Gasoline Engines	1.4	1.2	1.3
Diesel Engines	2.1	2.2	2.1
Engine Parts	1.9	1.8	1.8
Car production	1.6		

Source: Author

4.2 Changes in Top Country Ranking: which rose and which dropped

(1) Auto Parts

Table 3 presents the changes among the top five countries in the auto parts GVC. The total value equates to exports plus imports. The order of the countries is based on the ranking in 2018. We created four groups for analysis: “Emerging,” “Remaining,” “Moderate Change,” and “Declining.” The Emerging group is defined as countries moving up more than ten spots in the ranking between 2000 and 2018. The Remaining group is defined as countries maintaining their ranking within four spots compared with their previous ranking. The Moderate change group is defined as countries changing spots in the range of five to nine. The Declining group is defined as countries decreasing their ranking more than ten spots.

Regarding the auto parts GVC in total, China falls under the Emerging group. US, Germany, Mexico, and Japan under the Remaining group. This means these

countries were top players in the auto parts GVC both in 2000 and 2018. China, as Emerging, was ranked 14 in 2000, with only a 1.2% share at that time. However, in 2018, it became one of the top three; its share increased to 7.7%, moving ahead of Mexico and Japan. The Chinese automobile industry started to grow rapidly in the 2000s as reflected in our analysis of the auto parts GVC.

When we look at the top 20 countries, Slovakia and Romania also fall under the Emerging group. In 2018, Slovakia was ranked 14 with a 1.9% share. In 2000, it had been ranked 27 with 0.5% share. In 2018, Romania was ranked 19 with 1.5% share. In 2000, it had been ranked 50 with 0.1% share.

Table 3. Changes in top five country ranking in the auto parts GVC total

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	14.1%	21.6%	0	-7.4%
Germany	2	3	13.5%	8.9%	1	4.6%
China	3	14	7.7%	1.2%	11	6.6%
Mexico	4	7	6.9%	5.8%	3	1.1%
Japan	5	4	5.4%	7.0%	-1	-1.6%

Source: Author

Table 4 shows the changes among the top five country rankings on the auto parts GVC supply side, those exporting auto parts to the world. Regarding the auto parts GVC supply, China again falls under the Emerging group while Germany, the US, Japan, and Mexico fall under the Remaining group. On the supply side, China's trade grew between 2000 and 2018. This means that their supporting industries, such as auto parts manufacturers, also grew. In 2000, China had been ranked 18 and its share only 0.8% in worldwide auto parts supply. In 2018, China moved to the fourth spot and its share rose to 8.4% in the world, almost the same as that of Japan.

When we look at the top 20, Thailand and Romania fall under the Emerging group. In 2018, Thailand was ranked 13 and its share was 2.1%. In 2000, it had been ranked 24 with 0.4% share. In 2018, Romania was ranked 14 with 1.8% share. In 2000, it had been ranked 43 with 0.1% share. The UK was one country under the Declining group. In 2018, the UK was ranked 16 with 1.7% share while in 2000, it had been ranked 6 with 5.4% share.

Table 4. Changes in top five country ranking in the auto parts GVC: supply side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
Germany	1	3	16.3%	11.0%	2	5.4%
US	2	1	11.0%	22.9%	-1	-11.9%
Japan	3	2	8.7%	12.4%	-1	-3.8%
China	4	18	8.4%	0.8%	14	7.6%
Mexico	5	8	7.2%	4.2%	3	3.0%

Source: Author

Table 5 shows the changes among the top five countries on the auto parts GVC demand side, importing auto parts. Regarding the auto parts GVC demand, as above, China falls under the Emerging group while the US, Germany, Mexico, and Canada fall under the Remaining group. On the demand side of the GVC, China saw growing volume in auto parts from 2000 to 2018. In 2000, China was ranked 13 with 1.5% share. In 2018, China moved to the third spot with 7.1% share in the world.

Looking at the top 20, Czechia, Slovakia, and Russia fall under the Emerging group. In 2018, Czechia was ranked 9 with a 2.7%. In 2000, it had been ranked 24 with 0.8% share. In 2018, Slovakia was ranked 10 with 2.6% share while in 2000, it had been ranked 26 with 0.6% share. In 2018, Russia was ranked 11 with 2.2% share. In 2000, it had been ranked 45 with 0.1% share.

Table 5. Changes in top five country ranking in the auto parts GVC: demand side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	17.2%	20.2%	0	-3.0%
Germany	2	5	10.7%	6.9%	3	3.8%
China	3	13	7.1%	1.5%	10	5.6%
Mexico	4	3	6.6%	7.4%	-1	-0.8%
Canada	5	2	4.9%	13.3%	-3	-8.5%

Source: Author

(2) Gasoline Engines

Table 6 presents the changes among the top five ranked countries in the gasoline engine GVC. Regarding gasoline engines in total, no country in the top five fell into the Emerging group. Those in the Remaining group were the US, Germany, Japan, Mexico, and Canada.

Although not in the top five, there were countries that fell under the Emerging group in the top 20: China, Thailand, Singapore, the UAE, and Russia. In 2018, China was ranked 6 with 5.6% share. In 2000, China had been ranked 21 with 0.5% share. In 2018, Thailand was ranked 10 with 2.8% share. In 2000, Thailand had been ranked 30 with 0.2% share. In 2018, Singapore was ranked 13 with 2.1% share. In 2000, it had been ranked 47 with 0.04% share. In 2018, the UAE was ranked 15 with 1.9% share. In 2000, it had been ranked 29 with 0.2% share. In 2018, Russia was ranked 20 with 1.4% share. In 2000, it had been ranked 41 with 0.1% share.

Table 6. Changes in top five country ranking in gasoline engines GVC total

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	18.2%	28.0%	0	-9.8%
Germany	2	4	9.0%	9.4%	2	-0.4%
Japan	3	3	7.6%	9.9%	0	-2.4%
Mexico	4	5	6.8%	6.0%	1	0.8%
Canada	5	2	6.7%	14.0%	-3	-7.4%

Source: Author

Table 7 shows the gasoline engines GVC supply side. Regarding the gasoline engine GVC supply among the top five, no country was categorized under the Emerging group. The Remaining group included Japan, the US, Germany, Hungary, and Mexico. Gasoline engines are among the most important components in automobile manufacturing. Emerging countries have been growing capabilities for this key component to improve their global competitiveness. In 2018, China was ranked 6 with a share of 5.8%. In 2000, China had been ranked 19 with a share of 0.3%. In 2018, Thailand was ranked 9 with a share of 4.1%. In 2000, Thailand had been ranked 25 with a share of 0.1%.

When we look at the top 20, the UAE, Singapore, and Poland fall into the Emerging group. In 2018, the UAE was ranked 12 with 3.2% share. In 2000, it had been

ranked 37 with 0.02% share. In 2018, Singapore was ranked 14 with 2.1% share. It had been ranked 31 with 0.0% in 2000. In 2018, Poland was ranked 20 with 1.0% share. It had been ranked 28 with 0.02% share in 2000.

Table 7. Changes in top five country rankings in gasoline engines GVC: supply side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
Japan	1	2	13.0%	19.1%	1	-6.1%
US	2	1	12.8%	24.4%	-1	-11.7%
Germany	3	5	9.7%	7.1%	2	2.6%
Hungary	4	4	7.3%	7.5%	0	-0.2%
Mexico	5	6	7.2%	7.1%	1	0.1%

Source: Author

Table 8 presents the gasoline engine GVC demand side. Regarding gasoline engine GVC demand, China falls under the Emerging group category. In 2000, China had been ranked only 19 in the world with a share of 0.7%. In 2018, it moved to the five spot with a share of 5.3%. As Chinese automobile manufacturing grows, the number of gasoline engines it produces is increasing. The other countries in the top five fall under the Remaining group: the US, Canada, Germany, and Mexico.

Table 8. Changes in top five country rankings in gasoline engines GVC: demand side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	24.0%	31.3%	0	-7.2%
Canada	2	2	9.1%	17.3%	0	-8.2%
Germany	3	3	8.3%	11.6%	0	-3.2%
Mexico	4	4	6.4%	5.0%	0	1.4%
China	5	19	5.3%	0.7%	14	4.6%

Source: Author

When we look at the top 20, Czechia, Russia, Turkey, Singapore, India, and Qatar fall under the Emerging group category. In 2018, Czechia was ranked 7 with 2.7% share. It had been ranked 21 with 0.5% share in 2000. In 2018, Russia was ranked 9

with 2.7% share. It had been ranked 54 with 0.04% share in 2000. In 2018, Turkey was ranked 10 with 2.3% share. It had been ranked 26 with 0.4% share in 2000. Singapore was ranked 12 with 2.2% share in 2018. It had been ranked 53 with 0.05% share in 2000. India was ranked 13 with 1.8% share in 2018. It had been ranked 41 with 0.1% share in 2000. Qatar was ranked 20 with 1.1% in 2018. It had been ranked 71 with 0.02% share in 2000. Belgium fell under the category of Declining. In 2018, Belgium was ranked 16 with 1.5% share. It had been ranked 5 with 4.4% in 2000.

(3) Diesel Engines

Table 9 shows the changes among the top five country rankings in the diesel engine GVC. Regarding the diesel engines, no country fell into the Emerging group. The Remaining group included the US, Germany, Japan, Mexico, and Canada. The countries and their rankings remained completely the same as those of gasoline engines. This might indicate that countries with sufficient technologies to develop and produce gasoline engines had the same capabilities in diesel engines. However, among the top 10, China fell under the Emerging group category. China was ranked 7 with a share of 4.8% in 2018. In 2000, China had been ranked 15 with a share of 1.7%.

When we look at the top 20, Belgium fell into the Declining group. In 2018, Belgium was ranked 17 with 7% share. It had been ranked 7 with 4.3% share in 2000.

Table 9. Changes in top five country rankings in diesel engines GVC: total

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	18.2%	28.0%	0	-9.8%
Germany	2	4	9.0%	9.4%	2	-0.4%
Japan	3	3	7.6%	9.9%	0	-2.4%
Mexico	4	5	6.8%	6.0%	1	0.8%
Canada	5	2	6.7%	14.0%	-3	-7.4%

Source: Author

Table 10 shows the diesel engine GVC supply side. Regarding diesel engine supply, no country appeared in the Emerging group from the top five or the top 10. China was ranked 14 with a share of 3.2% in 2018, while it had been ranked 17 with a share of 1.0% in 2000. Thailand was ranked 13 with a share of 3.2% in 2018. It had been ranked 15 with a share of 1.1% in 2000. The situation was different from that for gasoline

engines. All top five countries fell under the Remaining group: the US, Germany, Japan, the UK, and France.

When we look at the top 20, Turkey fell into the Emerging group category. In 2018, Turkey was ranked 19 with 0.6% share, while it had been ranked 34 with 0.1% share in 2000.

Table 10. Changes in top five country rankings in diesel engines GVC: supply side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
Japan	1	2	13.0%	19.1%	1	-6.1%
US	2	1	12.8%	24.4%	-1	-11.7%
Germany	3	5	9.7%	7.1%	2	2.6%
Hungary	4	4	7.3%	7.5%	0	-0.2%
Mexico	5	6	7.2%	7.1%	1	0.1%

Source: Author

Table 11 shows the diesel engine GVC demand side. Regarding diesel engine demand, China fell into the Emerging group. China was ranked 5 with a share of 5.3% in 2018. In 2000, China had been ranked 19 with a share of 0.7%. The rest of the top five fell into the Remaining group: the US, Canada, Germany, and Mexico. Their ranking in 2018 was exactly as it had been in 2000.

Table 11. Changes in top five country rankings in diesel engines GVC: demand side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	24.0%	31.3%	0	-7.2%
Canada	2	2	9.1%	17.3%	0	-8.2%
Germany	3	3	8.3%	11.6%	0	-3.2%
Mexico	4	4	6.4%	5.0%	0	1.4%
China	5	19	5.3%	0.7%	14	4.6%

Source: Author

When we look at the top 20, Czechia, Russia, Thailand, and Slovakia fell into the Emerging group. In 2018, Czechia was ranked 10 with 2.9% share. It had been

ranked 21 with 1.1% share in 2000. Russia was ranked 12 with 2.0% share in 2018. It had been ranked 38 with 2.0% share in 2000. Thailand was ranked 18 with 1.6% share in 2018. It had been ranked 36 with 0.3% in 2000. Slovakia was ranked 19 with 1.5% share in 2018. It had been ranked 66 with 0.1% in 2000. The country falling into the Declining group was Canada. In 2018, Canada was ranked 16 with 1.9% share. It had been ranked 5 with 6.7% in 2000.

(4) Engine Parts

Table 12 shows the changes among the top five country rankings for engine parts for the GVC. Regarding engine parts, China fell into the Emerging group. China was ranked 3 with a share of 7.2% in 2018. In 2000, it had ranked 15 with a 1.6%. The rest of the top five fell into the Remaining group: Germany, the US, Japan, and Mexico. China was among the top five in both gasoline engines and engine parts in 2018. This might mean that the ability to produce gasoline engine parts is enough for China. The last step is to develop and produce the engine itself in the case of gasoline engines. The case for diesel engines is different. Although some possible reasons for this difference could be surmised, such as market demand, political directivity, technology, environmental issue, global regulations for diesel engines, and exhaust gas, among others, further study on this is required.

When we look at the top 20, India falls into the Emerging group. In 2018, India was ranked 18 with 1.8% share. It had ranked 29 with 0.5% share in 2000.

Table 12. Changes in top five country rankings for engine parts GVC: total

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
Germany	1	2	15.4%	12.4%	1	3.0%
US	2	1	11.8%	18.9%	-1	-7.1%
China	3	15	7.2%	1.6%	12	5.7%
Japan	4	3	6.5%	10.0%	-1	-3.5%
Mexico	5	5	6.1%	5.2%	0	0.8%

Source: Author

Table 13 shows the engine parts GVC supply side. Regarding engine parts supply, China fell into the Emerging category. China was ranked 4 with a share of 8.5% in 2018. In 2000, it had ranked 14 with 0.9% share. The rest of the top five fell into the Remaining group: Germany, Japan, the US, and Mexico. Among the top 10, some other countries fell into the Emerging group category: South Korea and Poland. In 2018, South Korea was ranked 6 with a share of 4.0%. It had been ranked 20 with 0.6% share in 2000. Poland was ranked 9 with a share of 3.1% in 2018. It had been ranked 21 with 0.6% share in 2000. Although not in the top 10, Thailand and India fell into the Emerging group category. In 2018, Thailand was ranked 13 with a share of 2.2%. It had been ranked 29 with 0.4% share in 2000. India was ranked 17 with 1.7% share in 2018. It had been ranked 30 with 0.4% share in 2000.

Canada and Austria both fell under the Declining group. In 2018, Canada was ranked 18 with 1.5% share while it had been ranked 5 with 4.9% share in 2000. Austria was ranked 20 with 1.5% share in 2018. It had been ranked 10 with 1.9% share in 2000.

Table 13. Changes in top five country rankings for engine parts GVC: supply side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
Germany	1	3	20.0%	16.8%	2	3.2%
Japan	2	1	9.9%	18.3%	-1	-8.5%
US	3	2	9.0%	18.1%	-1	-9.2%
China	4	14	8.5%	0.9%	10	7.6%
Mexico	5	4	6.3%	5.3%	-1	1.0%

Source: Author

Table 14 shows the engine parts GVC demand side. Regarding engine GVC demand, although China's improved ranking (up eight spots) was meaningful, almost into the Emerging group, it fell into the Moderate change group here. China was ranked 5 with a share of 5.3% in 2018. In 2000, it had been ranked 19 with a share of 0.7%. The rest of the top five fell into the Remaining group: the US, Canada, Germany, and Mexico. Their ranking in 2018 was exactly as it was in 2000. India was the only country in the Emerging group in the top 20. India was ranked 17 with 1.8% share in 2018. It had been ranked 27 with 0.6% share in 2000.

Table 14. Changes of top five country ranking of engine parts GVC: demand side

	Rank		Share		Difference (2000–2018)	
	2018	2000	2018	2000	Rank	Share
US	1	1	14.7%	19.7%	0	-5.0%
Germany	2	3	10.6%	7.8%	1	2.8%
UK	3	5	6.5%	5.7%	2	0.8%
China	4	12	5.9%	2.2%	8	3.7%
Mexico	5	6	5.8%	5.1%	1	0.7%

Source: Author

5. Discussion and Conclusion

This study investigates changes in countries' market shares between 2000 and 2018 in the GVC for automobile manufacturing. The following is a summary of the findings.

5.1 Global Trade of Auto Parts Grow

As described in Section 4.1, car production increased from 58.4 million units in 2000 to 95.6 million units in 2018. The change in units equates to a multiple of 1.6 during this timeframe. In the same period, total trade in auto parts multiplied by 2.1, gasoline engines by 1.3, diesel engines by 2.1, and engine parts by 1.8. Thus, between 2000 and 2018, the GVC spread and increased in volume.

5.2 Change in Top Players

As described in Section 4.2, the countries were categorized into four types: “Emerging,” “Remaining,” “Moderate change,” and “Declining.” To distinguish the changes further, the following categories were established: Countries in the Remaining group in the top five between 2000 and 2018 are designated as “Big;” Countries in the Emerging group in the top five in 2018 are designated as “Hopes.” Those in Emerging group not yet ranked in the top five but in the top 20 are designated as “Newcomers.”

Tables 15 to 17 present the Big, Hopes, and Newcomers, respectively, in terms of the total GVC, the GVC supply side, and the GVC demand side. In several of the tables, the same countries appear under Big, such as the US, Germany, Mexico, Japan, Canada, or the UK. Historically, there has been a strong, growing automobile industry in these countries with many, solid domestic suppliers.

Table 15. Big, Hopes, and Newcomers in GVC: Total

	Big	Hopes	Newcomers
Auto parts , general	US, Germany, Mexico, Japan	China	Slovakia, Romania
Gasoline engines	US, Germany, Japan, Mexico, Canada		China, Thailand, Singapore, UAE, Russia
Diesel engines	US, Germany, Mexico, UK, Japan		
Engine parts	Germany, US, Japan, Mexico	China	India

Source: Author

Table 16. Big, Hopes, and Newcomers in GVC: supply side

	Big	Hopes	Newcomers
Auto parts general	Germany, US, Japan, Mexico	China	Thailand, Romania
Gasoline engines	Japan, US, Germany, Hungary, Mexico		China, Thailand, UAE, Singapore, Poland
Diesel engines	USA, Germany, Japan, UK, France		Turkey
Engine parts	Germany, Japan, US, Mexico	China	South Korea, Poland, Thailand, India

Source: Author

Table 17. Big, Hopes, and Newcomers in GVC: demand side

	Big	Hopes	Newcomers
Auto parts general	US, Germany, Mexico, Canada	China	Czechia, Slovakia, Russia
Gasoline engines	US, Canada, Germany, Mexico	China	Czechia, Russia, Turkey, Singapore, India, Qatar
Diesel engines	US, Mexico, Germany, Spain	(China)*	Czechia, Russia, Thailand, Slovakia
Engine parts	US, Germany, UK, Mexico	(China)*	India

* China is categorized under Hope in diesel engines and engine parts. Although China is not categorized in the Emerging group, it is just on the border.

Source: Author

There are some major automotive production countries missing from these tables as this analysis focused largely on the top five and the Emerging group. However, these other countries are also important. If we categorize them, they could be named “Semi-Big.” Semi-Big countries are those such as France, Italy, Spain, South Korea, and Austria, etc. among others.

In several tables, China appears under Hopes. The Chinese automobile industry grew rapidly in the 2000s. Today, China is the top automobile producing country beyond the US, Japan, and Germany. This extends beyond the final car to the supporting parts industries, which are also growing rapidly.

Under the Newcomers, some countries appear in several tables in various groups such as Thailand, India, Romania, Czechia, and Singapore etc. In the GVC for various auto parts, although the Big countries have significant presence, those categorized under Hopes and Newcomers are also increasing. Thus, the GVC for auto parts is not fixed but flexible and expanding. In future study, case studies of these countries could be investigated.

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References

- Baba (2013) *Economic Development and Industrial Technology in Asia*, Nakanisiya-shobo
- Baba (2016) *Developing Model of Auto Parts in Emerging Economies: Comparative Analysis of the International Competitiveness of Auto Parts in Mexico, Brazil and India from 1990 to 2014*, 24th International Colloquium of GERPISA
- Fujimoto (2013) *The Strategy of Bottom-up Approach: The Theory of Japanese Industry to the Next Generation*, Shincho-shinsyo (in Japanese)
- OICA: <http://www.oica.net/> (as of 25th May 2020)
- UN Comtrade: <https://comtrade.un.org/> (as of 25th May 2020)
- World Bank Open Data: <https://data.worldbank.org/> (as of 25th May 2020)