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Firm and Product Heterogeneity in China's Automotive Exports*

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ABSTRACT

The main purpose of this paper is to provide an in-depth analysis of the anatomy of China's automotive exports, relying on the literature on firm and product heterogeneity. For this purpose, we use highly disaggregated HS 8-digit product-category level data collected by the Chinese Customs Office for 2000 and 2008, and we distinguish between foreign firms, domestic public firms, and domestic private firms. We also decompose automotive products into autos and auto parts and components (P/C). We then calculate both the extensive margins – number of products exported – and intensive margins – average value of exports per product – of China's automotive exports. We estimate gravity equations to assess the determinants of China's exports of autos and auto P/C. Overall, our analysis yields a number of new, interesting stylized facts about China's automotive exports by confirming the need for taking into account different types of heterogeneity in analyzing international trade.

1. Introduction

The automotive industry is an important symbol of modern industry. It has important linkages to several key segments of the economy, and it is often an important component of the industrialization process. The industry contributes not only to the development of manufacturing and transportation but also creates large number of jobs in a wide range of industries: metal materials, mechanical equipment, fixtures, electronics, rubber, engineering plastics, textiles, glass, automotive oil, and so forth.

One significant feature of the auto industry is that a small number of global mega-sized firms from few countries dominate the market. Since the late 1980s, large carmakers shifted their parts and components (P/C)

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factories and production bases to developing countries to lower production costs or seek markets. Likewise, large automakers increasingly outsource the production of P/C to outside suppliers to lower their costs. [1] Today, the global automotive industry is geographically fragmented, and the production process is split into different phases carried out in different countries. This geographical fragmentation of global auto production is driven by global mergers, direct investment and international outsourcing. [2]

Fragmentation has resulted in an explosive expansion in the trade of P/C due to the expansion of back-and-forth transactions in vertically fragmented cross-border production processes (Amighini, 2012).Thus, Kierzkowsk (2011) notes that vertical product differentiation, intra-industry trade and fragmentation of production leading to international outsourcing are important features of the existing global automotive sector. Empirical studies on automotive trade have concentrated on these features. [3]

First, many studies have examined intra-industry trade.Montout, et al. (2002) consider the determinants of intra-industry trade (IIT) for autos and auto parts and components (P/C) in NAFTA. Türkcan and Ates (2010; 2011) also examine auto P/C for the US by breaking down the bilateral trade flows into inter-industry trade, vertical IIT and horizontal IIT.Leitão, et al. (2010) also utilize panel data to examine the determinants of vertical intra-industry trade (VIIT) in the auto P/C industry between Portugal and the 27European Union and the 4 BRIC countries. Ito and Umemoto (2004) investigate recent trends and patterns of intra-regional trade and IIT, focusing on the auto and auto P/C industries in the ASEAN-4 countries. Umemoto (2005) investigates auto P/CIIT between Korea and Japan. Lefilleur (2008) confirms that the high levels of IIT between core CEECs and their neighboring countries in the ex-EU-15 are due to the decomposition of production processes within the central basin, initiated by significant relocation of foreign direct investment. All these studies conclude that intra-product specialization or vertical specialization has become an essential part of the regional integration of automobile production.

Second, from the perspective of recent research on international trade and firm heterogeneity, [4] some studies have begun to use micro-datasets to analyze the global fragmentation of automobile production and intra-firm trade between parents firms and affiliates. Using data fromToyota and Honda, Yoshida (2005) examines regional trade in auto parts and components (P/C) trade between Japan and other Asian countries. The results show that FDI by the Japanese automakers contribute to promoting regional trade of intermediate goods in the case of Japanese exports, but not in the case of Japanese imports. Since extensive margin versus intensive margin is a key conceptual distinction in the theoretical model of Melitz (2003) on firm heterogeneity, some studies estimate extensive and intensive margins of automotive trade. For example, Swenson (2012) uses Chinese product trade data for 1997 to 2009 to find that foreign-affiliated firms have mitigated the effects of China's content-based auto import trade policy by reducing import transaction prices and by reducing import quantities on the extensive margin. Using US auto industry data from 1996 to 2008, Türkcanand Yoshida (2010) examine the contribution of extensive and intensive margins to variation in intra-industry trade (IIT). They find that intensive margins have positive effects on the IIT of both auto industry and auto P/C industry.

Third, some studies have begun to look at emerging markets that may benefit from the new trade patterns in the automotive industry. In the next few decades, the major sources of growth in the automotive industry are predicted to lie in the emerging markets, such as China and India (Kierzkowski, 2011). A study by Nag, et al. (2007) on China, India, Indonesia and Thailand examines the growth patterns, changes in ownership structures, trade patterns, and the role of government. They distinguish trade in auto P/C from auto trade to help explain the different features of the auto trade of different countries. Amighini (2012) compares the relative positions of China and India in the international fragmentation of auto production, and highlights the unique characteristics of the Chinese auto industry. Noble (2006) also offers a summary of how the Chinese and Indian auto industries have emerged. China opened its domestic market to foreign automakers in the 1980s. Through the extensive use of the joint venture form cooperation, the government hoped that the Chinese domestic firms would learn from foreign firms and eventually become internationally competitive. [5] Only very few scholars use micro data to analyze China's automotive industry. For example, as noted above, Swenson (2012) uses China's micro trade data for 1997 to 2009 to assess whether foreign-affiliated firms differentially changed their input sourcing, in response to content-based import tariffs China imposed on imported auto parts. Amighini (2012) also uses micro data, to highlight the unique characteristics of the Chinese auto industry.

The main purpose of this paper is to analyze the determinants of China's automotive exports, using highly disaggregated HS 8-digit product-category level data collected by the Chinese Customs Office for 2000 and 2008. Following Lee et al. (2013), we distinguish firms by forms of ownership, foreign versus domestic firms, which are then further divided into public firms and privately-owned firms. While Lee et al (2003) focus on China's aggregate imports, decomposed into imports of final products and imports of intermediate products, this paper focuses on China's automotive trade.

Like our paper, Amighini (2012) analyzes China's automotive trade pattern by distinguishing auto P/C from autos, and compares it with India's automotive trade patterns. However, our paper differs from Amighini (2012) in that he uses the SITC rev.3 classification code but we use the 8-digit Harmonized System (HS) of China to analyze not only differences between autos and auto P/C but also differences among firm types. The present paper is also different from Amighini (2012) in that we estimate a gravity equation to examine the determinants of China's exports of both autos and auto P/C. As noted above, Swenson (2012) also differentiates P/C from final products in China's auto imports to assess the

[1] For an overview of global automotive industry, see Sturgeon, et al. (2009) and Kierzkowski (2011).

[2] International fragmentation of production and global value chain has drawn a lot of attention from scholars. See for example, Arndt and Kierzkowski eds. (2001), Athukorala (2005, 2009, 2010), Athukorala and Yamashita (2006), Ando and Kimura (2003, 2009) and Kimura (2009).

[3] In this paper, automotive trade refers to both trade in automobiles and trade in auto parts and components (P/C). Also, trade in automobiles is referred to as auto trade and trade in auto parts and components are referred to as auto P/C.

[4] Since the seminal paper by Melitz (2003), the focus of international trade research has changed to firm heterogeneity, as well summarized in Bernard, et al. (2011). Empirical studies confirmed that when compared with domestic firms, foreign-invested firms are more productive and often generate productivity "spillover" to the host country (Lu, et al., 2010). Using data from China, a number of recent empirical studies have described the different characteristics of different ownership firms in China's trade (Lee, et al., 2013; Manova, et al., 2011 and Du, et al., 2012).

[5] See Chu (2011) for a comprehensive summary of how the Chinese government promoted its automotive industry.

economic effects of content-based import tariffs China imposed on imported auto parts, but the present paper focuses on China's auto exports.

The paper is organized as follows. Using the product level data collected by China's Customs Office, Section 2 reports China's disaggregated automotive exports data by different types of firms for the two years - 2000 and 2008.For comparative purposes, China's corresponding imports data are also reported. Section 3 presents the empirical framework we use to estimate trade in auto P/C and trade in autos, by different types of firms. Section 4 reports and discusses the empirical results. Section 5 summarizes the main findings and concludes the paper.

2. Data Description

China has emerged as the factory of the world, with a strong comparative advantage in manufactured goods, particularly in parts and components, including in the auto industry. China's automotive industry grew rapidly to overtake the US and became the world's largest in 2009. However, China's auto imports have been always greater than its exports, and China's trade deficit in automotive trade has been growing in recent years (Fig. 1). In contrast, China's exports and imports of auto P/C have been increasing at a similar growth rate, resulting in balance. By comparing Fig. 1 and 2, it is also worth noting that China's exports of auto P/C have been growing more rapidly than its exports of autos, while China's imports of autos have been growing more rapidly than its imports of auto P/C.

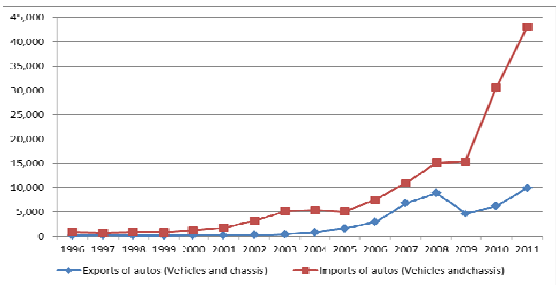

Fig. 1. Trend of China's auto export and import values (Unit: US$ million)
Source: Authors' drawing using China statistical yearbook 1996-2011

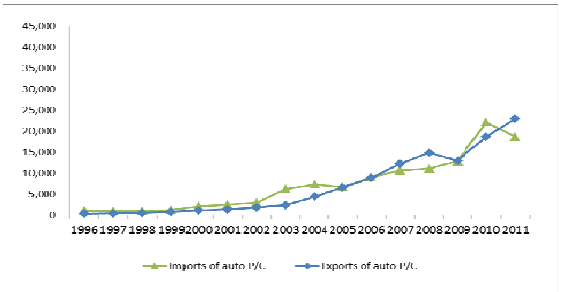

Fig. 2. Trend of China's auto P/C export and import values (Unit: US$ million)
Source: Authors' drawing using China statistical yearbook 1996-2011

In the following of this section, we report the disaggregated automotive exports (and imports for comparison) of China by different types of firms for the two years - 2000 and 2008. We use the Chinese Customs Office's disaggregated trade data which includes the freight on board (FOB) value of both exports and imports in China for 243 destination/source economies and 7,526 different products. For each shipment, the database also provides information on the type of firm, transportation mode, customs office, and firm's geographic information.

However, we must pay careful attention to the classification of auto P/C. While motor vehicles are mainly classified into HS code 87, a large number of auto P/C come under a different heading: tires and rubber products (40), glass (70), electronic products (84, 85), seats (94), and so on. This paper classifies auto P/C based on the China Association of Automobile Manufactures (CAAM) and the China Automotive Industry Yearbook, which provides information on the comprehensive coverage of auto P/C based on the HS code at the 8 digit level.

2.1. *Different Importance of Final and Components Trade by Firm Types*

Table 1 summarizes the relative shares of different firms in China's exports and imports of different kinds of auto products. In the case of China's exports of autos, domestic public firms have played a major role but their role has been decreasing: in 2008, domestic public firms accounted for 47.7% of auto exports, down from 82% in 2000.In contrast, foreign firms have played a major role in imports of autos as well as the exports and imports of auto P/C. In 2008, foreign firms accounted for 61.3% of China's auto P/C exports. Foreign firms accounted for 64.9% of China's auto imports in 2008, up from 39.3% in 2000.Foreign firms played even a bigger role in the imports of auto P/C than in the imports of autos. In 2008, foreign firms accounted for 71.8% of China's auto P/C imports. To summarize, except for exports of final auto products, foreign-invested firms dominated China's trade of autos and auto P/C.

Table 1
Exports and imports of China's different types of auto motive products by different types

(Unit: US$ million)

	Exports				Imports			
	2000	%	2008	%	2000	%	2008	%
Autos (Vehicle and Chassis total)	**193.7**	**100.0%**	**9562.3**	**100.0%**	**1193.2**	**100.0%**	**15181.8**	**100.0%**
Domestic public firms	158.9	82.0%	4563.4	47.7%	579.3	48.6%	2925.8	19.3%
Domestic private firms	3.3	1.7%	2824.7	29.5%	119.4	10.0%	2214.1	14.6%
Foreign-invested firms	31.2	16.1%	2168.4	22.7%	469.2	39.3%	9850.1	64.9%
Other	0.3	0.2%	5.8	0.1%	25.2	2.1%	191.8	1.3%
Parts and components	**3116.0**	**100.0%**	**39875.3**	**100.0%**	**2823.0**	**100.0%**	**25094.0**	**100.0%**
Domestic public firms	1064.3	34.0%	6986.5	17.5%	1305.6	45.9%	5427.8	21.6%
Domestic private firms	10.3	0.3%	8434.5	21.2%	12.2	0.4%	1650.3	6.6%
Foreign-invested firms	2040.4	65.7%	24453.2	61.3%	1504.0	53.6%	18013.4	71.8%
Other	1.0	0.03%	1.1	0.003%	1.2	0.04%	2.5	0.01%

Source: Authors' calculation using data from Chinese Customs Office

2.2. *China's Auto Export Destination and Import Source Countries*

Table 2 shows the top 10 auto trading partners of China. In 2008, Russia was the number one destination for China's auto exports, followed by Algeria, Vietnam, and Iran. In contrast, China imported cars from mostly Germany, Japan, the U.S. United Kingdom, and Korea. This suggests that China imported expensive high-end cars from the major auto making countries, while it exported inexpensive low-end cars to the not-so-high income countries.

Table 3 shows the top 10 trading partners of China for auto P/C. In 2008, the U.S. was the largest destination for China's exports of auto P/C, followed by Japan, Korea, and Germany. Interestingly, Japan, Germany, the U.S. and Korea were also the major sources of China's imports of auto P/C. Thus, unlike auto trade, China's trade of auto P/C is in the form of intra-industry trade with the auto producing countries.

Table 2
The top 10 of China's auto export destination and import source countries

(Unit: US$ million)

	Export				Import			
NO.	2000		2008		2000		2008	
1	Iraq	48.3	Russia	1276.0	Japan	621.0	Germany	4773.6
2	Hong Kong	37.7	Algeria	555.0	Germany	221.9	Japan	4372.9
3	Korea,DPR	26.0	Vietnam	512.3	United States	89.7	United States	2142.1
4	Sudan	17.8	Iran	503.2	Korea Rep	63.5	United Kingdom	986.2
5	Kazakhstan	9.1	Ukraine	477.8	Slovakia Rep	46.5	Korea Rep	947.5
6	Slovakia Rep	5.8	Angola	357.6	Byelorussia	27.0	Slovakia Rep	747.9
7	Bangladesh	4.2	United Arab Emirat	288.8	Russia	19.5	Sweden	318.6
8	Turkey	3.6	Saudi Arabia	255.1	Czecho Rep	19.4	Austria	208.3
9	Mongolia	3.0	Syrian	243.6	Hungary	16.8	Italy	117.9
10	Vietnam	2.9	S.Africa	240.4	Romania	13.3	Canada	116.0

Source: Authors' calculation using data from Chinese Customs Office

Table 3
The top 10 of China's auto P/C export destination and import source countries

(Unit: US$ million)

	Export				Import			
NO.	2000		2008		2000		2008	
1	United States	824.6	United States	10291.8	Japan	1112.8	Japan	9017.4
2	Japan	492.9	Japan	5242.2	Germany	351.2	Germany	5875.2
3	Hong Kong	270.4	Korea Rep	2065.5	United States	267.1	United States	2021.9
4	Germany	123.4	Germany	1410.2	Taiwan prov.	232.3	Korea Rep	1946.7
5	Korea Rep	103.8	Hong Kong	1266.7	Korea Rep	164.1	France	730.1
6	United Arab Emirate	90.2	Canada	992.7	United Kingdom	124.0	Hungary	658.6
7	Indonesia	87.7	United Arab Emirat	980.3	France	67.7	Italy	484.8
8	Australia	76.1	United Kingdom	942.3	Canada	62.4	United Kingdom	482.5
9	Singapore	74.4	Netherlands	940.9	Italy	60.0	Taiwan prov.	346.3
10	Netherlands	73.4	Italy	858.7	Hong Kong	58.6	Spain	297.9

Source: Authors' calculation using data from Chinese Customs Office

2.3. *Extensive and Intensive Margins*

The seminal Melitz (2003) model suggests that micro-heterogeneity influences aggregate outcome. In this model, the extensive margin of the number of exporting firms should grow with the size of the destination market since firms of lower productivity can generate sufficient variable profits to cover the fixed costs of exporting in the larger markets. Recently, the importance of extensive margin versus intensive margin in firm heterogeneity in international trade has been highlighted in various studies (for example, Bernard, et al., 2007; 2009; Chaney, 2008; Amiti and Freund, 2010; and Lee, et al., 2013).

In this paper, we define extensive margin as the number of exported/imported products (final automobiles or P/C) and intensive margin as the average value (unit price) of each exported/imported product.

Table 4 and Table 5 summarize the extensive and intensive margins of China's total auto exports and imports, respectively, by different types of firms.

Table 4
Extensive and intensive margins of China's auto exports by different types of firms

	Exports								
	A: Total value of exports			B: Extensive margin (Number of exported products)			C: Intensive margin Average value of each exported product		
	(US$ Million)						(US$)		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
Vehicle and Chassis	193.7	9,562.3	4835.6%	22,779	1,451,859	6273.7%	8,505.3	6,586.2	-22.6%
Domestic public firms	158.9	4,563.4	2772.1%	18,333	420,108	2191.5%	8,666.6	10,862.3	25.3%
Domestic private firms	3.3	2,824.7	84470.7%	221	783,254	354313.6%	15,113.4	3,606.4	-76.1%
Foreign-invested firms	31.2	2,168.4	6844.3%	4,114	247,763	5922.4%	7,590.0	8,751.7	15.3%
Passenger vehicles	67.2	4,075.1	5965.2%	6,301	1,140,120	17994.3%	10,663.0	3,574.3	-66.5%
Domestic public firms	45.1	1,628.1	3513.0%	4,004	259,257	6375.0%	11,254.4	6,280.0	-44.2%
Domestic private firms	2.2	1,033.4	46248.0%	128	700,106	546857.8%	17,419.8	1,476.1	-91.5%
Foreign-invested firms	19.8	1,407.7	6999.8%	2,166	180,024	8211.4%	9,153.7	7,819.4	-14.6%
Commercial vehicles	126.6	5,487.2	4235.8%	16,478	311,739	1791.8%	7,680.2	17,601.9	129.2%
Domestic public firms	113.8	2,935.2	2478.8%	14,329	160,851	1022.6%	7,943.5	18,248.1	129.7%
Domestic private firms	1.1	1,791.3	161227.6%	93	83,148	89306.5%	11,939.1	21,543.3	80.4%
Foreign-invested firms	11.4	760.7	6573.8%	1,948	67,739	3377.4%	5,851.2	11,229.6	91.9%

Source: Authors' calculation using data from Chinese Customs Office
Note: Intensive margin is the total value of exports divided by the number of exported products

Table 5
Extensive and intensive margins of China's auto import by different types of firms

	Imports								
	A: Total value of imports			B: Extensive margin (Number of imported products)			C: Intensive margin Average value of each imported product		
	(US$ Million)						(US$)		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
Vehicle and Chassis	1,193.2	15,181.8	1172.4%	42,374.0	411,092	870.2%	28,158.5	36,930.4	31.2%
Domestic public firms	579.3	2,925.8	405.0%	16,997.0	78,722	363.2%	34,084.8	37,166.4	9.0%
Domestic private firms	119.4	2,214.1	1754.9%	5,460.0	56,104	927.5%	21,861.3	39,463.7	80.5%
Foreign-invested firms	469.2	9,850.1	1999.1%	19,319.0	270,114	1298.2%	24,289.3	36,466.4	50.1%
Passenger vehicles	859.2	14,127.7	1544.3%	37,470.0	400,682	969.3%	22,930.0	35,259.2	53.8%
Domestic public firms	328.5	2,398.6	630.1%	13,555.0	75,069	453.8%	24,236.1	31,951.5	31.8%
Domestic private firms	117.8	1,797.5	1425.4%	5,412.0	50,529	833.6%	21,773.4	35,573.6	63.4%
Foreign-invested firms	402.9	9,740.5	2317.4%	18,008.0	268,940	1393.4%	22,375.2	36,218.0	61.9%
Commercial vehicles	334.0	1,054.1	215.6%	4,904.0	10,410	112.3%	68,108.0	101,255.6	48.7%
Domestic public firms	250.8	527.2	110.2%	3,442.0	3,653	6.1%	72,870.0	144,332.3	98.1%
Domestic private firms	1.5	416.6	27220.9%	48.0	5,575	11514.6%	31,765.3	74,721.3	135.2%
Foreign-invested firms	66.3	109.6	65.3%	1,311.0	1,174	-10.5%	50,582.1	93,369.1	84.6%

Source: Authors' calculation using data from Chinese Customs Office
Note: Intensive margin is the total value of imports divided by the number of imported products

As seen in panel B of Table 4, the extensive margin (the number of exported products) increased between 2000 and 2008 for auto exports, conducted by all types of firms. In particular, that of private firms increased by 354,313.6% to export 783,254 vehicles and chassis in 2008. For further analysis, we divided the whole sample into passenger vehicles and commercial vehicles. Extensive margins increased in both types of autos but increased more rapidly in passenger vehicles.

Panel C of Table 4reports the intensive margin (the average value of each exported product) of auto imports. The average value of each exported product decreased for the exports of autos in the case of domestic private firms. In fact, the intensive margin decreased for the exports of passenger vehicles in all three types of firms. This is in contrast to the exports of commercial vehicles in that the intensive margin increased in all types of firms. However, even in the case of commercial vehicles, the increase in intensive margin is relatively smaller than that in extensive margin. Thus, the increase in the total value of autos was mainly due to the increase in the number of exported products, rather than the increase in the average value of each exported product.

Table 5 reports the extensive and intensive margin of auto imports. As seen in panel B of the table, the number of imported auto products increased between 2000 and 2008 in most cases. The increase in the extensive margin is greater in the case of passenger vehicle imports than in the case of commercial vehicle imports. Indeed, in 2008, China imported mostly passenger vehicles, rather than commercial vehicles.

Panel C of Table 5also reports the intensive margin of the average value of each imported product. The intensive margin grew fast between 2000 and 2008, irrespective of the types of firms. When compared with exports, the average price of imported products is significantly higher than that of exported products, suggesting that China exports low-end autos and imports high-end autos.

Table 6and Table 7 summarizes the extensive and intensive margins of China's auto P/C exports and imports, respectively, by different types of firms. Since some of auto P/C are traded in kilograms instead of number of P/C, the margins are also divided into two different units: number of exporting products (unit 1) and the total weights in kilograms (unit 9).

As seen in panel B of the tables, the extensive margin (in both numbers and weights) increased between 2000 and 2008 for exports and imports in P/C goods in most cases. In particular, the extensive margin of private firms increased significantly, while that of domestic public firms increased less visibly during the period. Among the three types of firms, foreign firms have the largest numbers and largest weights for both export and imports of auto P/C.

Panel C of Table 6 and Table 7report the intensive margin– the

average unit value of each exported and import product, respectively. The intensive margin grew fast between 2000 and 2008, irrespective of the types of firms. In 2008, the intensive margin was similar among the three types of firms for both exports and imports.

Table 6
Extensive and intensive margins of China's auto P/C exports by different types of firms

	Exports								
	A: Total exports			B: Extensive margin (Number or weights of exported products)			C: Intensive margin (Average unit value per each exported product		
	(US$ Million)						(US$)		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
					(Number)				
Parts and components by unit 1	2,210.1	20,264.9	816.9%	7,632	17,336	127.2%	0.3	1.2	303.7%
Domestic public firms	741.4	3,919.8	428.7%	1,809	2,820	55.9%	0.4	1.4	239.2%
Domestic private firms	6.5	3,549.6	54555.5%	16	2,658	16642.7%	0.4	1.3	226.4%
Foreign-invested firms	1,461.2	12,794.6	775.6%	5,807	11,858	104.2%	0.3	1.1	328.8%
					(Weights)				
Parts and components by unit 9	905.9	19,610.4	2064.8%	326	4,972	1425.4%	2.8	3.9	41.9%
Domestic public firms	322.9	3,066.7	849.6%	156	872	459.2%	2.1	3.5	69.8%
Domestic private firms	3.8	4,885.0	128986.8%	2	1,578	80366.9%	1.9	3.1	60.4%
Foreign-invested firms	579.2	11,658.6	1913.0%	168	2,522	1400.9%	3.4	4.6	34.1%

Source: Authors' calculation using data from Chinese Customs Office
Note: In the case of P/C by unit 1, the extensive margin is the number of exporting products, but in the case of P/C by unit 9, the extensive margin is the total weights in kg. Intensive margin is the total value of exports divided by the extensive margin exported products

Table 7
Extensive and intensive margins of China's auto P/C imports by different types of firms

	Imports								
	A: Total imports			B: Etensive margin (Number or weights of imported products)			C: "Gooh" intensive margin (Average unit value per each imported product		
	(US$ Million)						(US$)		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
					(Number)				
Parts and components by unit 1	1,703.5	14,560.4	754.7%	5,289	12,244	131.5%	0.3	1.2	269.2%
Domestic public firms	761.9	3,644.7	378.4%	2,011	1,940	-3.5%	0.4	1.9	396.0%
Domestic private firms	6.7	1,143.9	16977.4%	23	1,379	5803.1%	0.3	0.8	189.3%
Foreign-invested firms	934.4	9,770.1	945.7%	3,253	8,925	174.3%	0.3	1.1	281.2%
					(Weights)				
Parts and components by unit 9	1,119.5	10,533.6	840.9%	126	786	521.3%	8.9	13.4	51.5%
Domestic public firms	543.8	1,783.2	227.9%	65	131	101.7%	8.4	13.6	62.6%
Domestic private firms	5.5	506.4	9167.6%	1	31	2203.3%	4.1	16.6	302.4%
Foreign-invested firms	569.7	8,243.3	1347.0%	60	624	937.0%	9.5	13.2	39.5%

Source: Authors' calculation using data from Chinese Customs Office
Note: In the case of P/C by unit 1, the extensive margin is the number of exporting products, but in the case of P/C by unit 9, the extensive margin is the total weights in kg. Intensive margin is the total value of imports divided by the extensive margin imported products

3. Empirical Specification

As noted in the introduction, we use the gravity equation to assess how the three different types of firms behave differently with respect to choosing their trading partners depending on different product types. Most empirical studies on automotive industry trade have thus examined intra-industry trade, and even though the gravity equation is a widely used analytical tool for bilateral trade, only few studies have applied gravity equations to the automotive industry trade. An exception is Nishitateno (2012) which estimates an augmented gravity equation to examine the FDI effect on the trade of Japanese auto industry using product-level data. Sichei, et al. (2008) applies an augmented gravity model to South Africa's export of autos and auto P/C using panel data.

In this section, we present the empirical framework we use to estimate the determinants of China's exports of autos and auto P/C. We do not consider China's imports because there are only few countries from which China imported cars in 2000 and 2008.Since Tinbergen (1962) and Pöyhönen (1963), the simple gravity equation, in which the volume of trade between two countries is proportional to the product of their masses (GDPs) and inversely related to the distance between them, has proved empirically highly successful. Indeed, many researchers have shown that the gravity equation can be derived from many different models of international trade (Helpman and Krugman, 1985; Bergstrand, 1989; Deardorff, 1998; Evenett and Keller, 2002; Eaton and Kortum, 2002).

In addition, researchers such as Anderson and van Wincoop (2003) have shown that bilateral trade depends not only on country size and distance, but also on multilateral price terms. In a panel setting, multilateral price terms can be accounted for by including country fixed effects. Thus, the standard gravity equation drawn from the basic form of the gravity model – the Anderson and Van Wincoop (2003) "gravity with gravitas" model - thus takes the following form:

$$(1)\ \mathrm{Ln}X_{ijt} = \alpha + \beta_1 \mathrm{Ln}GDP_{it} + \beta_2 \mathrm{Ln}GDP_{jt} + \beta_3 \mathrm{Ln}\tau_{ijt} + \varepsilon_i + \varepsilon_j + \varepsilon_{ijt},$$

Where

$\mathrm{Ln}X_{ijt}$ =Natural logarithm of export flows from country *j* to country *i* at time *t*

$\mathrm{Ln}GDP_{it}$= Natural logarithm of GDP of country *i* at time *t*

$\mathrm{Ln}GDP_{jt}$= Natural logarithm of GDP of country *j* at time *t*`

$\mathrm{Ln}\tau_{ijt}$: transaction costs

ε_i = i country fixed effects

ε_j= j country fixed effects

ε_{ij} = random disturbance term.

Although the gravity model is commonly used in estimating the pattern of international trade, estimating the log-linearized equation by least squares (OLS) might lead to biases in the presence of severe heteroskedacity, as argued in Santos Silva and Tenreyro (2006). As an alternative, Santos Silva and Tenreyro (2006) suggest that the gravity model be estimated in its multiplicative form and use a Poisson pseudo-maximum likelihood (PPML) estimator that is usually used for count data. Another desirable property of PPML is that a Poisson estimator naturally includes observations for which the observed value is zero, while such observations are dropped from the OLS model because the logarithm of zero is undefined. In the present paper, this feature is also very important because we disaggregate China's automotive exports in various ways and hence exports value in each disaggregated gravity equation includes a number of observations with zero values. Therefore, we apply the PPML estimator and estimate a multiplicative form model (i.e., without taking the log of the value of exports as the dependent variable).

Since country *i* stands for only one country (China) and our sample comprises only two years (2000 and 2008), we do not include variables for country *i* (i.e. China). And, instead of country fixed effects, we include a remoteness index for country *j* as GDP-weighted distance from all trading partners. We also add a year dummy to account for the overall change in China's auto exports.

Therefore, Equation (1) becomes:

$$(2)\ X_{jt} = \alpha + \beta_1 \mathrm{Ln}GDP_{jt} + \beta_2 \mathrm{Ln}REMOTE_{jt} + \beta_3 \mathrm{Ln}\tau_{jt} + \varepsilon_t + \varepsilon_{jt}.$$

Where

X_{jt} =Export flows to China from country *j* at time t

ε_t = 1 if year is 2008 and 0 if year is 2000.

$\mathrm{Ln}REMOTE_{jt}$= Natural logarithm of remoteness of country *j* at time *t*

$$= \mathrm{Ln}(1/\textstyle\sum_{k \neq j}(\mathrm{GDP}_{kt}/\mathrm{GDP}_{wt})/\ \mathrm{DIST}_{jk})$$

Where

GDP_{kt} = GDP of country k at time t; GDP_{wt} = world GDP at time t;

$DIST_{jk}$ = geographical distance between country *j* and country *k*

In the equation above, we assume that the transaction costs, τ, take the following functional form:[6]

$$\tau_{jt} = Dist_j^{\delta_1} \cdot exp\left(\delta_2 ISLAND_j \cdot \delta_3 LANDLOCKED_j \cdot \delta_4 RTA_{jt} \cdot \delta_5 WTO_{jt}\right)$$

Where

$ISLAND_j$= 1 if country *j* is an island country
= 0 otherwise

$LANDLOCKED_j$ = 1 if country *j* is a landlocked country
= 0 otherwise

RTA_{jt} = 1 if country *j* is China's RTA partner at time t
= 0 otherwise

WTO_{jt} = 1 if country *j* is a WTO member at time t[7]
= 0 otherwise

Lastly, Anderson and van Wincoop (2003) suggest that the sector version of the gravity model include sector specific expenditure and output rather than GDP and therefore we include automobile sales value of importing country instead of GDP. But because auto P/C trade is not only related to the automotive sales but also to the automotive production of importing country, we also estimate the equation including the automotive production value of importing country in place of automotive sales. In addition, we include GDP per capita of importing country in order to assess importing counties' income effect on China's auto exports. Thus, our augmented gravity equation is:

(3) $X_{jt} = \alpha + \beta_1 \text{Ln}SALES_{jt} + \beta_2 \text{Ln}PGDP_{jt} + \beta_3 \text{Ln}REMOTE_{jt} + \delta_1 \text{Ln}DIST_j + \delta_2 ISLAND_j + \delta_3 LANDLOCKED_j + \delta_4 RTA_{jt} + \delta_5 WTO_{jt} + \varepsilon_t + \varepsilon_{jt}$,

Or

(3)' $X_{jt} = \alpha + \beta_1 \text{Ln}PRODUCTION_{jt} + \beta_2 \text{Ln}PGDP_{jt} + \beta_3 \text{Ln}REMOTE_{jt} + \delta_1 \text{Ln}DIST_j + \delta_2 ISLAND_j + \delta_3 LANDLOCKED_j + \delta_4 RTA_{jt} + \delta_5 WTO_{jt} + \varepsilon_t + \varepsilon_{jt}$,

Where

LnSALES_{it} = Natural logarithm of automobile sales in country *i* at time t

LnPRODUCTION_{jt}= Natural logarithm of automobile production in country *j* at time t[8]

LnPGDP_{it} = Natural logarithm of GDP per capita in country *i* at time t

For exports of autos, equation (3) will be estimated and for exports of auto P/C, equations (3) and (3)' will be estimated. Among the explanatory variables, PGDP (in US dollars) is taken from the World Bank's WDI Online data.[9] Geographical distance is taken from Centre d'Etudes Prospective et d'Informations Internationales (CEPII)'s website.[10] It is noted that the distances are weighted distances, which use city-level data to assess the geographic distribution of population inside each nation. The variables indicating whether the country is landlocked or island are also taken from CEPII's website. Lastly, information on the members of the World Trade Organization (WTO) is taken from the website of the WTO and information on China's RTA is from China's official website "China FTA Network.[11] The automotive sales and production data are taken form Organization Internationale des Constructeurs d'Automobiles(OICA)'s website.[12] In the case of sales, the data are available only from 2005 and therefore the sale values for 2005 were used for 2000 in the regression analysis.

As discussed above, China's aggregate exports to country j can be decomposed into the extensive margin of the number of exported product and the intensive margin of average unit value of each exported product. Therefore the extensive margin and the intensive margin will also be regressed separately against the regressors in the gravity equation presented in Equation (3). Note that in the equations for exports of P/C, we use only the intensive margin in US dollars, but not in weights.

4. Empirical Results

Table 8 shows the regression results for the gravity model in which the dependent variable is the value of exports of two groups of products - autos and auto parts and components(P/C) - for three different types of firms - public, private and foreign. In the case of regressions for auto P/C exports, only the observations in terms of the number of units (but not weights) are included. As discussed in the previous section, the estimates are obtained by the PPMLestimator.

China exports more autos and auto P/C to countries with larger automotive sales or larger automotive production, irrespective of the types of firms and products. The exception here is the auto exports of public firms which is not associated with automotive production of importing countries. It is important to note, however, that the size of the estimates for sales and production is larger in the equations for auto P/C exports than that in the equations for auto exports. Another noticeable difference between auto and auto P/C exports is that per capita GDP (PGDP) of partner countries is significant in all types of firms for auto P/C but for autos it is only marginally significant for foreign firms. Thus, China's automotive firms, in general, export auto P/C to larger countries - in terms of automobile sales and production - and to higher income countries, but they export autos to larger countries but not to higher income countries, except foreign firms. This finding is consistent with what we observed in Section 2 that in the years of 2000 and 2008, the top 10 destinations for China's auto exports were mostly developing countries such as Iraq, North Korea, and Sudan, while those for China's exports of auto P/C were high-income countries such as U.S., Japan, and Germany, as reported in Tables 2 and 3. It is also noted that as compare to auto exports, Chinese auto P/C exports are more responsive to automotive sales and production of importing countries. Significantly, among the three types of firms, foreign firms are more responsive to per capita GDP of importing countries, suggesting that foreign firms export relatively more expensive high-end cars than domestic Chinese firms.

In addition, distance does not appear to matter for autos, while it

[6] It is also customary to include a dummy variable for country pairs sharing a land border. China shares borders with a number of countries, and hence we initially included a dummy variable for these border-sharing countries, but we found no significant results.

[7] China became a WTO member in December 2001. For the debate about the role of the WTO, see Rose (2004; 2005) and Subramanian and Wei, 2007).

[8] Zero observations are replaced with 1 before taking logs.

[9] http://publications.worldbank.org/WDI

[10] http://www.cepii.fr/anglaisgraph/bdd/distances.htm

[11] http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx;
http://fta.mofcom.gov.cn/topic/chinaasean.shtml
Wikipedia (http://en.wikipedia.org/wiki/Trade_bloc#Most_active_regional_blocs)

[12] http://www.oica.net/

matters for auto P/C exports of foreign invested firms. And the estimated coefficients for the remoteness variable are statistically insignificant in most equations, suggesting that multilateral resistance terms do not matter in China's exports of autos and auto P/C. On the other hand, dummy variables for island countries and landlocked countries are both negative and significant in most equations, suggesting that China exports less autos and auto P/C to islands and landlocked countries.

We have two variables related with trade policies of China and partner countries: WTO dummy variable and RTA dummy variable. We find that the coefficient of WTO dummy is negative and significant in the auto regressions, irrespective of types of firms. It is also negative and significant in the auto P/C regression for private firms. Only in the equation for foreign firms' exports of auto P/C, WTO dummy enters with statistically significant positive coefficient. Thus, we have evidence that exports less autos and auto P/C to other WTO member countries. This is at odds with common wisdom that China, which joined the WTO in 2001, would export more autos to other WTO members. But this is consistent with the stylized facts reported in Table 2, which shows that most of the top 10 destinations of China's auto exports are non-WTO members such as Iran, North Korea, Sudan, and Kazakhstan.

Our regression results also show that China's regional trade agreements do not have a significant positive effect on the exports of auto P/C, except for private Chinese firms' exports of auto P/C. However, there is a need for further research on this because our dataset has only one home country and two years. We are thus unable to account for the possible endogeneity issues suggested by Baier and Bergstrand (2007).

Table 9 reports the results when the dependent variable is the extensive margin of China's exports - the number of exported products - for different types of goods - autos versus auto P/C – by different types of firms.[13] For dummy variables such as Island, Landlocked, RTA, and the WTO, the results for the extensive margin are very similar to those for the total value reported in Table 8. The estimated results for the key gravity variables such as the income and geographic distance reveal some differences. For the sake of easy comparison, Table 10summarizes the estimates for automotive sales/production and per capita GDP of partner countries as well as the geographic distance between China and its partner countries.

China's automotive firms, irrespective of their types, export not only a larger value but also a larger number of autos and auto P/C to countries that are large in terms of automotive sales and production. Foreign-invested firms export more to high income countries not only in terms of total value but also the number of autos. Specifically, for foreign invested firms, a 10 percent increase in per capita income of importing countries is associated with a 3 percent increase in total exported value and a 4.6 percent increase in the number of exported autos. Interestingly, China's private firms also export a greater number of autos to higher-income countries. Combined with the finding that they do not export a greater value of autos to higher-income countries, this finding suggests that China's private firms export cheaper autos to higher-income countries. Also, only China's private firms export a greater number of auto P/C to higher-income countries. In contrast, public and foreign firms export a greater total value of auto P/C to higher-income countries, but do not export a greater number of auto P/C.

Finally, geographic distance does not appear to matter in China's exports of autos, both in terms of total value and the number of products, but it matters in China's exports of auto P/C in terms of the number of products, irrespective of types of auto makers. However, it enters with a statistically significant coefficient only in the equation for foreign firms' exports of auto P/C expressed in terms of total value rather than the number of products. Thus, foreign-invested firms appear to export more auto P/C to geographically closer countries both in terms of total value and the number of products.

5. Concluding Observations

Using highly disaggregated HS 8-digit product-category level data collected by the Chinese Customs Office for 2000 and 2008, we perform an in-depth analysis of the anatomy of China's automotive exports. The rich data set allows us to distinguish firms into foreign firms and domestic firms, which are further divided into private firms and public firms. In addition, we distinguish products into autos and auto parts and components (P/C).We also estimate the relative importance of extensive margin – number of exported/imported products – versus the intensive margin – the average unit value of each exported/imported product. Finally, we estimate gravity equations to better understand the role of both firm and product heterogeneity in China's auto and auto P/C exports.

Our analysis yields a number of new interesting stylized facts about China's automotive industry. First, international fragmentation has become an essential part of the China auto-industry and foreign invested firms play a dominant role in China's automotive trade.

Second, China exports low-end autos to not-so-high-income countries and imports high-end autos from high income countries, while it exports auto P/C to high income countries and imports auto P/C from high income countries.

Third, China's automotive firms, in general, export auto P/C to larger countries - in terms of automobile sales and production - and to higher-income countries, but it exports autos to larger countries but not to higher-income countries, except foreign firms. Overall, compared to auto exports, Chinese auto P/C exports are more responsive to automotive sales and production of importing countries.

Forth, China's automotive firms, irrespective of their types, export a larger number of autos and auto P/C to countries with large automotive sales. China's private firms and foreign-invested firms also export a larger number of autos to high income countries.

Overall, we find substantial differences across different types of products and different types of firms. Therefore, our empirical analysis of the PRC's automotive trade resoundingly confirms the need for taking into account different types of heterogeneity in analyzing international trade. Decomposing trade behavior along firm and product lines allows us to better capture the richness and complexity of international trade.

References

Amighini, A. A. (2012), "China and India in the International Fragmentation of Automobile Production," *China Economic Review*, Vol.23, No.2, pp.325-341.

Amiti, M. and C. Freund (2010), "An Anatomy of China's Export Growth", In Robert Feenstra and Shang-Jin Wei (Eds.), *China's Growing Role in World Trade*, University of Chicago Press, pp. 35-56.

[13] We do not use the intensive margin - the average value of each exported product - of China's exports as another dependent variable in the regression analysis, because in bilateral exports of final or P/C auto products by different types of firms to individual countries there are many observations with zero values for the extensive margin and hence the intensive margin – exports value divided by the extensive margin - is undefined in many cases.

Anderson, J.E. and E. van Wincoop (2003), "Gravity with Gravitas: A Solution to the BorderPuzzle," *American Economic Review*, Vol.93, pp.170-192.

Ando, M. and F. Kimura (2003), "The Formation of International Production and Distribution Networks in East Asia," NBER Working Papers, No.10167, National Bureau of Economic Research.

Ando, M. and F. Kimura (2009), "Fragmentation in East Asia: Further Evidence," Discussion Papers, No.DP-2009-20, Economic Research Institute for ASEAN and East Asia (ERIA).

Arndt, S. W. and H. Kierzkowski (Eds.) (2001), *Fragmentation: New Production Patterns in the World Economy*, Oxford: Oxford University Press.

Athukorala, P. (2005), "Product Fragmentation and Trade Patterns in East Asia," Asian Economic Papers, Vol. 4, No.3, pp.1-27.

Athukorala, P. (2009), "Production Networks and Trade Patterns: East Asia in a Global Context," Departmental Working Papers, 2009-15, Australian National University, Economics Research School of Pacific and Asian Studies.

Athukorala,P. (2010), "Production Networks and Trade Patterns in East Asia: Regionalization or Globalization?," ADB Working Paper, No.56, Asian Development Bank (ADB).

Athukorala,P.andY.N.Yamashita (2006), "Production Fragmentation and Trade Integration: East Asia in a Global Context", *North American Journal of Economics and Finance*, Vol. 17, pp.233-256.

Baier, S. L., and J. H. Bergstrand (2007), "Do Free Trade Agreements Actually Increase Members' International Trade?," *Journal of International Economics*, Vol. 71, No.1, pp.72-95.

Bergstrand, J. (1989), "The Generalized Gravity Equation, Monopolistic Competition, and Factor Proportions Theory in International trade," *Review of Economics and Statistics*, Vol. 71, pp.143–153.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007), "Firms in International Trade," *Journal of Economic Perspectives*, Vol. 23, No.3, pp.105-130.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2009), "The Margins of U.S. Trade," *American Economic Review Papers and Proceedings*, Vol. 99, pp.487-493.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2011), "The Empirics of Firm Heterogeneity and International Trade," NBER Working Paper Series, No. w17627, National Bureau of Economic Research (NBER).

Chaney, T. (2008), "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review*, Vol.98, No.4, pp.1707-1721.

Chu, W. W. (2011), "How the Chinese Government Promoted a Global Automotive Industry," *Industrial and Corporate Change*, Vol. 20, No.5, pp.1235–1276.

Deardorff, A. (1998), "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?," Frankel, J. (eds.), *The Regionalization of the World Economy*, Chicago: University of Chicago Press.

Du, J., Y. Lu, Z. Tao,and L. Yu (2012), "Do Domestic and Foreign Exporters Differ in Learning by Exporting? Evidence from China," *China Economic Review*, Vol. 23, No.2, pp.296-315.

Eaton, J. and S. Kortum (2002), "Technology, Geography, and Trade", *Econometrica*, Vol. 70, pp.1741-1780.

Evenett, S. and W. Keller (2002), "On Theories Explaining the Success of the Gravity Equation", *Journal of Political Economy*, Vol. 110, No.2, pp. 281-316.

Helpman, E. and P. R. Krugman (1985), *Market Structure and Foreign Trade*, Cambridge: MIT Press.

Ito, K., and M. Umemoto (2004), "Intra-Industry Trade in the ASEAN Region: The Case of the Automotive Industry," Working Paper Series, No.23, International Centre for the Study of East Asian Development (ICSEAD).

Kierzkowski, H. (2011), "A New Global Auto Industry?," *China and World Economy*, Vol.19, No.1, pp.63-82.

Kimura, F. (2009) "The Spatial Structure of Production/Distribution Networks and Its Implication for Technology Transfers and Spillovers," Discussion Papers, No.d005, Economic Research Institute for ASEAN and East Asia (ERIA).

Lee, H. -H., D.Park, and J. Wang (2011), "The Role of the People's Republic of China in International Fragmentation and Production Networks: An Empirical Investigation," ADB Working Papers on Regional Economic Integration, No.87, Asian Development Bank.

Lee, H. -H., D. Park, and J. Wang (2013), "Different Types of Firms, Different Types of Products, and Their Dynamics: An Anatomy of China's Imports," *China Economic Review*, Vol.25, pp.62-77.

Lefilleur, J. (2008),"Geographic Reorganization of the European Automobile Sector", *Eastern Economic Studies*, Vol.46, No.5, pp.71-94.

Leitão, N.C., H. C.Faustino, and Y. Yoshida (2010), "Fragmentation, Vertical Intra-Industry Trade, and Automobile components," *Economics Bulletin*, Vol. 30, No. 2, pp.1006-1015.

Lu, J., L. Yi, and Z. Tao (2010), "Exporting Behaviour of Foreign Affiliates: Theory and Evidence," *Journal of International Economics*, Vol.81, pp.197-205.

Manova, K., S. J. Wei, and Z. Zhang (2011), "Firm Exporters and Multinational Activity under Credit Constraints", NBER Working Paper Series, No. 16905, National Bureau of Economic Research (NBER).

Melitz, M. J. (2003),"The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol.71, No.6, pp.1695-1725.

Montout, S., J.L. Mucchielliand S. Zignago (2002), "Regionalization and Intra-industry trade: An Analysis of Automotive industry Trade in NAFTA," *Region et Development*, Vol.16, pp.137-159.

Nag, B., S. Banerjee and R. Chatterjee (2007), "Changing Features of the Automotive industry in Asia: Comparison of Production, Trade and Market Structure in Selected Countries," Working Paper No.37, Asia-Pacific Research

and Training Network on Trade (ARTNeT), United Nations Economic Commission for Asia and the Pacific (UNESCAP).

Nishitateno, S. (2012), "Global Production Sharing in the Japanese Automotive industry: A Comparative Analysis," Australian National University, Arndt-Corden Department of Economics Working Papers in Trade and Development, No. 2012-2.

Noble, G. W. (2006), "The Emergence of the Chinese and Indian Automobile Industries and Implications for other Developing Countries," Background Paper for Dancing with Giants: China, India, and the Global Economy, Institute for Policy Studies and the World Bank. Washington, DC.

Pöyhönen, P. (1963), "A Tentative Model for the Volume of Trade between Countries," *WeltwirtschaftlichesArchiv*, Vol.90, pp.93-100.

Rose, A. (2004), "Do We Really Know that the WTO Increases Trade?" *American Economic Review*, Vol.94, No.1, pp.98-114.

Rose, A. (2005), "Which International Institutions Promote International Trade?," *Review of International Economics*, Vol.13, No.4, pp.682-709.

Santos Silva, J.M.C. and S. Tenreyro (2006), "The Log of Gravity," *Review of Economicsand Statistics*，Vol.88, No.4, pp.641-658.

Sichei, M. M., J. L. Erero, and T. Gebreselasie (2008), "An Augmented Gravity Model of South Africa's Exports of Motor Vehicles, Parts and Accessories: Economics," *South African Journal of Economic and Management Sciences*, Vol.11, No.4, pp.494-510.

Subramanian, A. and S.-J. Wei (2007), "The WTO Promotes Trade, Strongly but Unevenly," *Journal of International Economics*, Vol.72, pp.151-175.

Sturgeon, T.J., O.Memedovic, J.V.Biesebroeck, and G. Gereffi (2009), "Globalization of the Automotive, Industry: Main Features and Trends," *International Journal of Technological Learning, Innovation and Development*, Vol.2, No.1/2, pp.7-24.

Swenson, D. L. (2012), "The Influence of Chinese Trade Policy on Automobile Assembly and Parts", *CESifo Economic Studies,* Vol.58, No.4, pp.703-730.

Tinbergen, J. (1962), *Shaping the World Economy- Suggestions for an International Economic Policy*, The Twentieth Century Fund.

Türkcan, K. and A. Ates (2010), "Structure and Determinants of Intra-industry Trade in the U.S.Auto-Industry," *Journal of International and Global Economic Studies*, Vol.2, No.2, pp.15-46.

Türkcan, K. and A. Ates (2011), "Vertical Intra-industry Trade and Fragmentation: An Empirical Examination of the US Auto- parts Industry", *The World Economy*, Vol. 34, No.1, pp.154-172.

Türkcan, K. & Yoshida, Y. (2010), "Extensive and Intensive Margins of U.S. Auto Industry Trade," mimeo, Accessed on April 18th, 2011.

Umemoto, M. (2005), "Development of Intra-Industry Trade between Korea and Japan: The Case of Automobile Parts Industry," CITS Working Paper Series, No. 2005-03, Center for International Trade Studies (CITS), Yokohama National University.

Yoshida, Y. (2005), "Outsourcing of Intermediate Manufacturing Products in Asian Economies," Kyushu Sangyo University Discussion Paper, No. 21, Kyushu Sangyo University, Faculty of Economics.