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Evolution of the Supplier Network in the German Automotive Industry from the Prewar to Postwar Period: A Comparative Perspective with the Japanese Experience

Hiroyuki Okamuro

The purpose of this paper is to investigate the development of the manufacturer-supplier relationship in the German automotive industry from the 1920s to the 1960s and to examine the continuity between the prewar and the postwar periods from a comparative perspective with the Japanese experience. Using original documents mainly from the DaimlerChrysler Archive and focusing on Daimler-Benz, I found that the postwar relationship in Germany is quite different from that in the prewar period. While an arm's-length relationship was dominant in the prewar period, the postwar relationship is more stable and characterized by intensive mutual commitment. An important turning point in the evolution of the supplier network can be found in the wartime economy. However, more direct reasons for the postwar changes include the new economic environment and experiences during the postwar period. As a whole, the evolution of the supplier relationship in Germany shows remarkable similarities to that in Japan. However, the formation of the stable and cooperative relationship in Japan was more directly influenced by the new conditions in the postwar period, especially at the beginning of motorization.

Business relationships between manufacturers and their suppliers are an important aspect of inter-firm networks. The extent of the vertical integration of production ("boundaries of the firm") and the organization of relationships with suppliers have been theoretically and empirically studied from different perspectives, including transaction cost economics, exit-voice theory, and the sociology of organization.

The purpose of this paper is to investigate the development of the manufacturer-supplier relationship in the German automotive industry from the 1920s to the 1960s and to examine the continuity between the

Hiroyuki Okamuro is in the Graduate School of Economics, Hitotsubashi University
Naka 2-1, Kunitachi Tokyo 186-8601 Japan; E-mail: okamuro@econ.hit-u.ac.jp

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prewar and the postwar periods. So far, there have been few detailed studies on this topic, although they would provide insightful evidence for related research fields.[1] Many have studied the introduction and development of the Ford system in the German automotive industry.[2] However, they focus on the internal production process and labor force organization and hardly refer to the supplier network. In addition, historical research on German carmakers has included little attention to the relationship with suppliers.[3]

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[1] My first tentative research on this topic was Hiroyuki Okamuro, "Buhin torihiki ni okeru kyoso to kyocho: Kodo seichoki Doitsu no jirei" ["Competition and Collusion in the Trading of Automotive Parts: A Case of West German Firms in the High-Growth Period"], *Ikkyo Ronso* (Hitotsubashi University) 120-6 (1998): 63-81, in which I focused on the process of price determination and product development in the 1950s and the early 1960s using historical documents of a supplier of engine parts.

[2] Compare Anita Kugler, "Von der Werkstatt zum Fließband: Etappen der frühen Automobilproduktion in Deutschland," *Geschichte und Gesellschaft* 13 (1987): 304-339; Jörg Bönig, *Die Einführung von Fließbandarbeit in Deutschland bis 1933: Zur Geschichte einer Sozialinnovation* (Münster, 1993); Hans-Joachim Braun, "Automobilfertigung in Deutschland von den Anfängen bis zu den vierziger Jahren," in *Die Entwicklung der Motorisierung im Deutschen Reich und den Nachfolgestaaten*, ed. Harry Niemann and Arnim Hermann (Stuttgart, 1995), 58-68; Volker Wellhöner, *Weltmarkt—"Wirtschaftswunder"—Westdeutscher Fordismus: Der Fall Volkswagen* (Münster, 1996); Reiner Filk, *Von Ford lernen? Automobilbau und Motorisierung in Deutschland bis 1933* (Cologne, 2001).

[3] For Daimler-Benz AG, see Max Kruk and Gerold Lingnau, *100 Jahre Daimler-Benz AG*: *Das Unternehmen* (Mainz, 1986); Hans Pohl et al., *Die Daimler-Benz AG in den Jahren 1933 bis 1945: Eine Dokumentation* (Stuttgart, 1987); Karl Heinz Roth and Michael Schmid, *Die Daimler-Benz AG 1916-1948: Schlüsseldokumente zur Konzerngeschichte* (Nördlingen, 1987); Hamburger Stiftung für Sozialgeschichte des 20. Jahrhunderts, *Das Daimler-Benz Buch. Ein Rüstungskonzern im 'Tausendjährigen Reich'* (Nördlingen, 1987); Bernard P. Bellon, *Mercedes in Peace and War: German Automobile Workers 1903-1945* (New York, 1990); Neil Gregor, *Daimler-Benz in the Third Reich* (London, 1997); and Yuji Nishimuta, *Nachizumu to Doitsu Jidosha Kogyo (Nazism and the German Automobile Industry*) (Tokyo, 1999). See Klaus-Jörg Siegfried, *Rüstungsproduktion und Zwangsarbeit im Volkswagenwerk 1939-1945: Eine Dokumentation* (Frankfurt am Main, 1987) and Hans Mommsen and Manfred Grieger, *Das Volkswagenwerk und seine Mitarbeiter im Dritten Reich* (Düsseldorf, 1996) for Volkswagen; Bernd Heyl and Andrea Neugebauer, eds., *"... ohne Rücksicht auf die Verhältnisse." Opel zwischen Weltwirtschaftskrise und Wiederaufbau* (Frankfurt am Main, 1997); Günter Neliba, *Die Opel-Werke im Konzern von General-Motors (1929-1948) in Rüsselsheim und Brandenburg* (Frankfurt am Main, 2000) and Reinhold Billstein et al., *Working for the Enemy:*

In this paper, I compare historical evidence from Germany with the findings from recent Japanese studies and evaluate them from the comparative perspective. There have been some comparative historical studies of the American and Japanese automotive industries, but German experiences present an interesting contrast to the American and Japanese cases.[4]

The manufacturer-supplier relationship in Germany has changed since the 1980s through the adoption of some factors of the Japanese manufacturing system, but little is known about the prior relationship. Some surveys during the 1970s and the early 1980s suggest that the manufacturer-supplier relationship in Germany was basically long-term and stable, similar to Japan, but German suppliers were less dependent on their customers than Japanese suppliers.[5] In general, we can position the manufacturer-supplier relationship in Germany somewhere between the traditional American and the Japanese patterns.

Close, long-term relations between carmakers and core suppliers, involving intensive cooperation and information exchange, characterize the Japanese supplier system.[6] This system, which became popular and attracted world-wide attention in the 1980s, is neither traditional nor stable, but has changed and developed by trial and error over many years, restricted by historical conditions. It was established in this stylized form

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Ford, General Motors and Forced Labor in Germany during the Second World War (New York, 2000) for Opel.

[4] Compare Susan Helper, "Comparative Supplier Relationship in the U.S. and Japanese Auto Industries: An Exit / Voice Approach," *Business and Economic History* 19 (1990): 153-162; Susan Helper and David I. Levine, "Long-Term Supplier Relations and Product-Market Structure," *Journal of Law, Economics and Organization* 8 (1992): 561-581.

[5] According to Dieter Kunz, *Die Marktstellung der mittelständischen Zulieferbetriebe* (Stuttgart, 1972), about 60% of the surveyed small suppliers in the metal and machinery industries have continued doing business with their largest customer for more than 11 years. Jürgen W. Hutzel, *Interdependenzen zwischen Klein-und Großfirmen* (Tübingen, 1981) reports that the proportion of the sales to the largest customer is less than 25% for most of the surveyed suppliers. Monopolkommission, *Mißbräuche der Nachfragemacht und Möglichkeiten zu ihrer Kontrolle im Rahmen des Gesetzes gegen Wettbewerbsbeschränkungen* (Baden-Baden, 1977) analyzed the relationship between carmakers and parts suppliers from the viewpoint of competition policy and confirmed mutual dependence between them. Hiroyuki Okamuro, "Nishi doitsu ni okeru shitauke torihiki—Chikara kankei to sono kitei yoin (Subcontracting Relationship in West Germany—Balance of Power and its Determinants)," *Ikkyo Ronso* (Hitotsubashi University) 100-6 (1988): 124-145, summarizes the results of various surveys on the subcontracting and supplier relationship in West Germany.

[6] See Toshihiro Nishiguchi, *Strategic Industrial Sourcing: The Japanese Advantage* (New York, 1994) for an extensive survey of the historical development and the recent practices of the Japanese supplier system as a whole.

at the beginning of the 1970s at the earliest.[7] There is still a conflict of opinions among Japanese scholars on when and how this system was formed, specifically on the continuity between wartime experience and postwar development.

Both Germany and Japan were latecomers to automobile production and the "Wunderkinds" of the postwar era. Germany is regarded as the country "where the automobiles are born," but the large-scale production and distribution of cars in Germany began in the 1950s, 30 to 40 years later than in the United States but 10 years earlier than Japan, as Table 1 shows. The German carmakers introduced the "American style of production" in the 1920s to increase production efficiency. In the 1930s, large-scale production began, but was soon hindered by wartime regulation. Therefore, motorization only fully developed in Germany since the 1950s (see Figure 1).[8]

TABLE 1
International Comparison of the "Car Density" 1914-1970
(Number of Motor Vehicles per 1,000 Inhabitants[a]

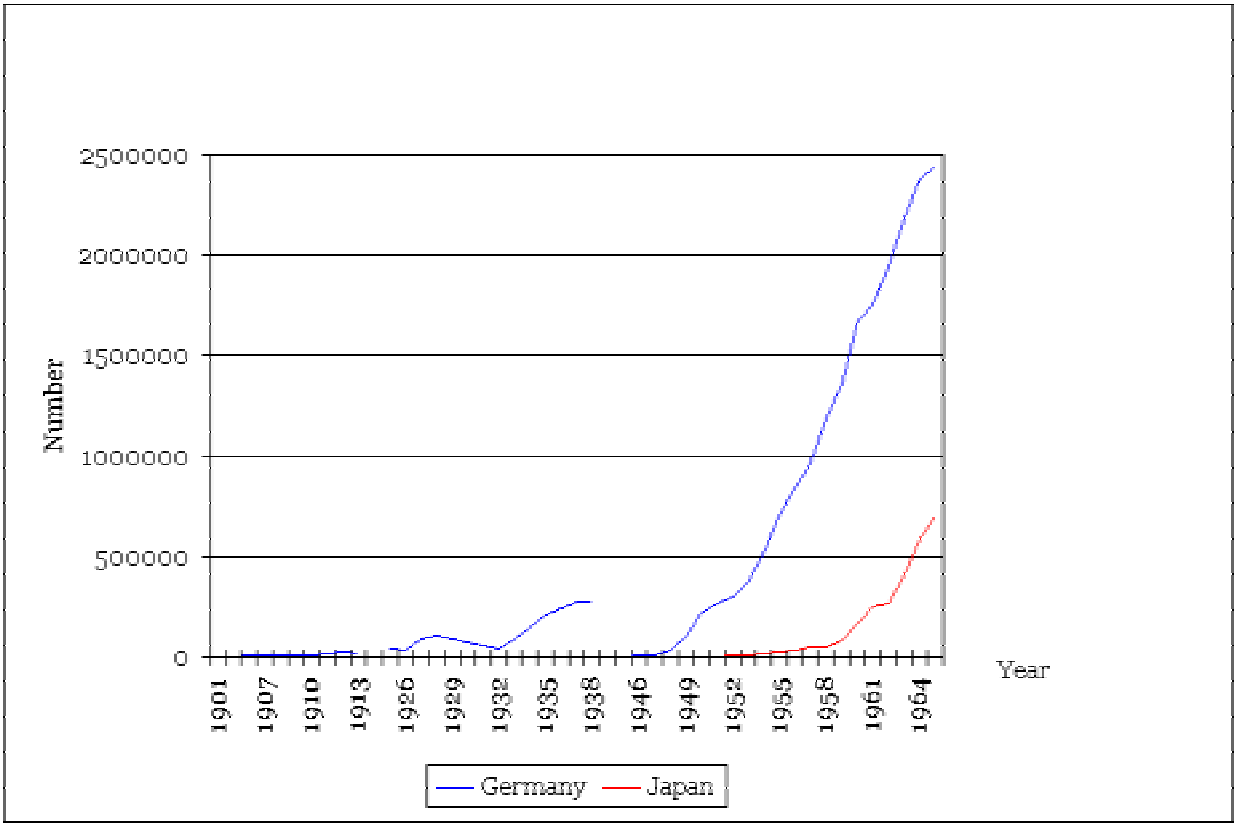
	1914	1920	1930	1938	1950	1955	1960	1965	1970
USA	17.8	87	217	200	250	303	336	376	426
Germany[b]	1	0.8	10.2	20.4	9.4	26	68	151	216
Japan	-	-	-	1.5	0.5	1.9	4	18	68

Sources: Reiner Filk, *Von Ford lernen?* (Cologne, 2001), 288 (Table 1); VDA, ed., *Tatsachen und Zahlen aus der Kraftverkehrswirtschaft*, various issues.
Notes:
[a]Number of cars after 1938.
[b]West Germany (Federal Republic of Germany) after 1950.

[7] Kazuo Wada, "Jidosha Sangyo ni okeru Kaisoteki Kigyokan Kankei no Keisei–Toyota Jidosha no Jirei" [The Development of Tiered Inter-Firm Relationships in the Automobile Industry: A Case Study of Toyota Motor Corporation], *Japan Business History Review* 26 (1991): 21.
[8] The production numbers after 1945 are limited to West Germany.

FIGURE 1

Car Production in Germany and Japan



Sources: Hans Christian Graf von Seherr-Thoss, Die Deutsche Automobilindustrie: Eine Dokumentation von 1886 bis heute, 2d ed. (Stuttgart, 1979); Hirofumi Ueda, Senjiki nihon no shitauke kogyo [Subcontracting Industries in Wartime Japan] (Tokyo, 2004).

Figure 1 also shows that car production in Japan was negligible during the prewar period and increased dramatically during the 1960s. Although production of trucks and mini-cars began in the 1920s, domestic production of cars began in 1936 and peaked in 1937 with only 1,819 cars produced. Postwar car production began in 1947, 2 years later than in Germany. The number of cars produced in Japan did not exceed 100,000 until 1960, 11 years later than in Germany. Though motor vehicle production in Japan was heavily focused on trucks rather than cars until the end of the 1960s, the difference in the development of automotive production between Germany and Japan is remarkable. This fact suggests that initial conditions and life cycle stages for the German and Japanese automotive industries differed in both the prewar and postwar periods. The impact of their wartime experiences with economic regulation and

military production may also have differed, despite some similarities as latecomers to the U.S. automotive industry.

In this paper, I deal with the long interval between the preparations for large-scale production and its implementation. From the German point of view, there were three periods: the prewar period from the 1920s to the 1930s; the regulation and wartime economy from 1939-1945; and the postwar period from the second half of the 1940s to the 1960s. My discussion is based on original documents from the corporate archives in Germany, mainly from the DaimlerChrysler Archive in Stuttgart and the Stiftung AutoMuseum Volkswagen in Wolfsburg. Due to limited data, we focus on Daimler-Benz AG, particularly with respect to the prewar period. It is also possible to use evidence from Daimler-Benz to discuss the evolution of the supplier network in the German automotive industry, as it was one of the major carmakers throughout the prewar and the postwar periods and played an important role in the wartime economy.[9]

Automotive parts suppliers in Germany can be roughly classified into three groups. The first group consists of suppliers of specialized components, such as Robert Bosch for electric parts and Fichtel & Sachs for clutch systems. They provided carmakers with specialized components beginning in the early years of the automotive industry, establishing a monopoly or dominant position in the market. The second group contains the huge steelmakers in the Rhine-Ruhr area, such as Krupp and Thyssen, which supplied large forged and pressed parts. Those in the third group are small manufacturers in the neighboring area that supplied various small forged, molded, or pressed parts. The suppliers discussed in this paper include all of these groups, but we will consider group differences in discussing the evolution of the supplier network.

The Prewar Period (1920s and 1930s)

Automobile production in Germany reached a turning point in the mid-1920s with the transition from artisan-style, separate production to American-style, assembly-line production. Many imported cars, mainly from the United States, were flown into Germany, and German carmakers, which were losing their competitiveness, were eager to introduce advanced production technologies.[10] Adam Opel was the first to introduce the innovation of assembly lines with conveyers in 1924, securing its position

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[9] There are 4 carmakers that survived the period from the 1920s to the 1960s:, Daimler-Benz, Opel, Audi (Auto Union), and BMW (Bayerische Motoren Werke [Bavarian Motor Works]). In both the 1930s and the 1950s, Daimler-Benz was the third or fourth largest carmaker as measured by the number of cars produced.

[10] The ratio of foreign cars in the registration of new cars in Germany increased from under 5% in 1923 to 12% in 1924, to 25% in 1925 and finally to 38% in 1929. Compare Filk, *Von Ford lernen*, 176, Table 11.

as the largest carmaker in Germany.[11] As shown in Table 2, Daimler-Benz introduced assembly lines in 1925 and the first conveyer in 1927 at the Sindelfingen plant.[12]

Before Daimler-Motoren-Gesellschaft AG and Benz & Cie. AG were merged to form Daimler-Benz AG in May 1926, they agreed on a comprehensive business alliance. At their joint meeting in May 1925, the board members discussed the introduction of "the American way of production" and decided to introduce assembly lines with conveyers in all of the factories and to set up the Central Purchasing Office (Zentraleinkauf) at the main plant in Untertürkheim. They discussed the make-or-buy policy of parts at both this meeting and the joint meeting of the board of directors and the board of supervisors (Aufsichtsrat) of the new company in October 1926.[13] Thus, the make-or-buy problem and the strengthening of the purchasing management were regarded as important agenda items for Daimler-Benz at the time.

With increased demand after 1927 (see Table 3), Daimler-Benz experienced a series of problems with delayed delivery and poor quality parts and materials. Detailed descriptions of these troubles are found in the protocols of regular meetings of engineering managers of the Gaggenau plant as well as the meetings of the Gaggenau managers with those of the Central Purchasing Office.

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[11] Compare Kugler, "Von der Werkstatt zum Fließband," Bönig, *Die Einführung von Fließbandarbeit in Deutschland bis 1933* vol. 1: 440ff and Filk, *Von Ford lernen*, 146ff for the development of the production technology at Opel. After introducing the conveyer system, car production at Opel increased to 20 cars per day, much higher than the average productivity of the carmakers at that time (fewer than 1 per day) and that of Daimler (4.4 per day) and Benz (5.3 per day); see Filk, *Von Ford lernen*, 160.

[12] The assembly line with conveyer system was introduced gradually into different production processes. Daimler-Benz introduced it to the production line of chassis as late as the second half of the 1930s; see Filk, *Von Ford lernen*, 227-8.

[13] DaimlerChrysler Archiv, Bestand Kissel 1.2, *Protokoll der Sitzung des Verwaltungsausschusses vom 18.10.1926 in Berlin*.

TABLE 2
Introduction of assembly lines and conveyers in the German Automotive Industry

Assembly Line	Conveyer	Firms (Plants)
1924	1924	Opel
1925	1929	Brennabor
	1925	Horch
1925	1926	Hanomag
1925		Adler
		Daimler-Benz
1925	1929	(Untertürkheim)
1925	1929	(Mannheim)
1925	1927	(Sindelfingen)
1926	1928	Wanderer
	1926	Selve
1927		Dixi
1927		NSU
1928		DKW
1929		Röhr
1929		Phänomen
1929		Audi
1929	1931	Stoewer
	1929	Goliath
1929		Hansa
		(Foreign Carmakers)
1925	1925	Ford
1926		Chrysler
1926	1927	General Motors
1926	1929	Hudson-Essex
1926	1926	Citroën

Source: Filk (2001): 223, Table 13.

TABLE 3
Development of the German Automotive Industry 1909-1936

Year	# of factories	Total # of Employees	Average Size[a]	Production of Cars	Production of Trucks and Buses	Production in Value[b]	Material Cost[b]	Labor Productivity[c]	Outsourcing Ratio[d]
1909	121	19,221	158.85	6,682	-	74,863	37,033.02	1968.2	0.49468
1910	114	21,813	191.34	8,578	790	107,119	52,750.64	2492.5	0.49245
1911	131	28,694	219.04	10,319	1,373	158,448	77,322.6	2827.2	0.488
1912	124	35,877	289.33	14,296	1,782	239,330	11,3170	3516.5	0.47286
1913	109	33,462	306.99	12,400	1,851	214,308	96,609	3517.4	0.4508
-	-	-	-	-	-	-	-	-	-
1925	235	86,642	368.69	38,988	10,304	1,093,804	544,052.6	6345.1	0.49739
1926	238	55,412	232.82	31,896	5,211	673,982	312,067.4	6531.3	0.46302
1927	244	83,424	341.9	84,610	11,972	1,524,401	696,725.2	6618.8	0.55787
1928	140	83,751	598.22	101,617	20,960	1,363,373	874,214.6	7763.3	0.57348
1929	128	76,441	597.2	96,161	31,577		740,194	8156.3	0.54279
1930	118	54,153	458.92	77,257	18,690	842,464	437,873.1	7471.3	0.51975
1931	102	46,134	452.29	62,529	15,034	526,890	257,846.9	5831.8	0.48937
1932	102	34,392	337.18	43,430	8,234	285,199	135,432.9	4354.7	0.47487
1933	81	51,036	630.07	92,160	13,261	448,238	189,594.9	5067.9	0.42298
1934	76	80,858	1063.9	147,330	27,325	794,448	380,195	5123.2	0.47856
1935	96	100,937	1051.4	205,092	41,528	1,184,037	636,640.9	5423.1	0.53769
1936	-	110,148	-	244,289	57,312	1,489,642	805,340.5	6212.6	0.54063
CV[e]		**0.324**				**0.439**	**0.501**		

Sources: Statistisches Reichsamt, *Statistisches Jahrbuch für das Deutsche Reich*, various issues.
Notes:
[a]Number of employees per factory.
[b]Unit of value: 1,000 Mark (1909-1913) and 1,000 Reichsmark (1925-1936), adjusted to real term using the wholesale price index (1913 = 100). The data before 1913 and after 1925 are not directly comparable because the method of measure was changed.
[c](production in value – material cost) / number of employees (1,000 Mark or 1,000 Reichsmark).
[d]Material cost / production in value.
[e]Coefficient of Variation = standard deviation / mean value for the period 1925-1936.

They coped with these troubles mostly by switching to in-house production when possible, or immediately switching to an alternative supplier. We assume that the frequent changes of the make-or-buy decision and of the suppliers were feasible, because the ordered volume was quite small and most parts except for "catalogue goods" were designed by the carmaker.[14]

The descriptions in the protocols further suggest that in many cases orders for each part were directed to a sole supplier, at least for orders from the Gaggenau plant. Thus, the purchase officers of this plant preferred concentrating the entire order of each part on the best supplier, avoiding the multiple sourcing risks of delivery and quality problems.

According to the protocols, the reasons for considering a change of suppliers were limited to serious problems with product quality and delivery. It is noteworthy that a variety of parts were often purchased from the same supplier; breaking off the purchase of one part from a supplier did not necessarily mean completely breaking off the relationship with this supplier.

The Great Depression, which seriously affected the German economy after 1930, had an important impact on Daimler-Benz's make-or-buy policy. At a meeting on October 10, 1930, the Central Purchasing Office demanded that the Gaggenau plant's top managers strictly limit orders of forged parts to maintain the rate of operation of the main factory Untertürkheim in Stuttgart.[15] Only 10 days later, President Wilhelm Kissel directed the Central Purchasing Office chief, Dexheimer, to limit any new outsourcing. Specifically, the purchase of parts from suppliers was limited to cases where in-house production was not feasible after considering every possibility. Any switches from in-house production to outside purchasing had to be approved by President Kissel and Director von Jungenfeld, the chief of the Gaggenau plant, based on comparative estimates of production cost.[16]

Thus, Daimler-Benz tried to cope with the crisis of the Great Depression by maintaining in-house production and reducing the purchase of parts. The remaining documents tell nothing about the feasibility or outcome of this policy. However, as Table 3 shows, the ratio of the material costs to the value of production in the German automotive industry in general decreased from 57 percent in 1928 to 42 percent in

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[14] No documents were found that directly showed that customer-designed parts were dominant at the time. However, later documents suggest that most parts except for catalogue goods were customer-designed.

[15] DaimlerChrysler Archiv, Bestand Kissel 1.5, *Bericht über Sitzung am 10. 10. 30 in Gaggenau*. In this meeting, the Central Purchasing Office expressed a strong distrust of the suppliers, blaming them for using poor material and doing poor work.

[16] DaimlerChrysler Archiv, Bestand Kissel 3.6, *Brief von Dir. Kissel an Dexheimer, Einkauf, am 20.10.30*.

1933, suggesting that there was a dramatic reduction in purchases from parts suppliers for the whole industry during the Great Depression.[17]

With the economic recovery in 1933, the demand for parts increased again. Therefore, the ratio of the material costs to the value of production increased rapidly to 54 percent in 1936. Figure 2 shows that the variations in the material costs compared to the previous year were always larger than those in the value of production during the period from 1926 and 1936. In addition, the coefficient of variation (standard deviation divided by the mean value) of the material costs in the same period (0.501) is higher than that of the value of production (0.439), as shown in Table 3. It suggests that the carmakers coped with the variations in demand by adjusting parts purchasing. That is, the outsourcing of parts was used to buffer demand variations in the prewar automotive industry.

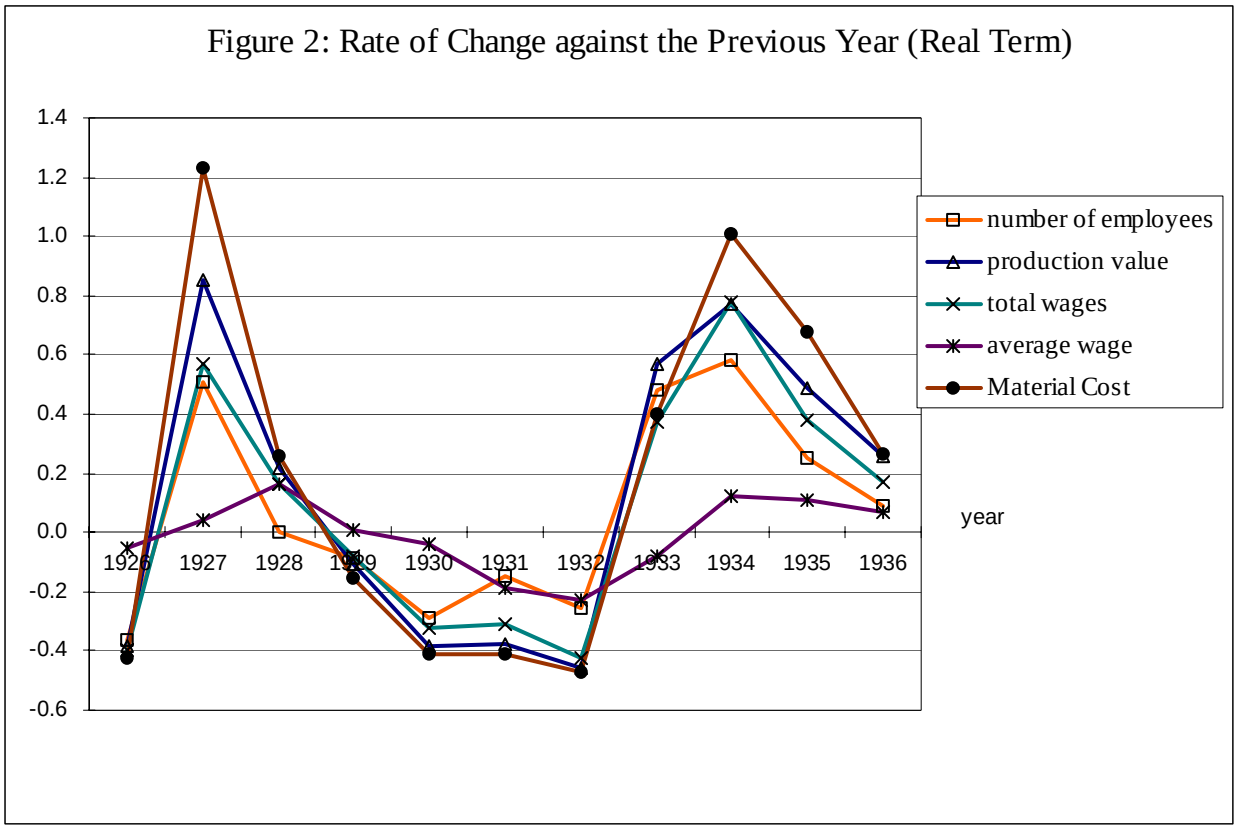
As discussed, the make-or-buy policy of Daimler-Benz from the second half of the 1920s to the beginning of the 1930s wavered between "pro-make" and "pro-buy" decisions, and the supplier network was characterized by the concentrated order of each part from a sole supplier, carmaker-designed parts, and the arm's length relationship. Daimler-Benz was concerned about the quality and delivery of purchased parts and tried to switch to another supplier or to in-house production immediately whenever serious troubles occurred. The frequency of such troubles may be ascribed to the insufficient technological and managerial capability of the suppliers as well as the failure of the purchasing management of Daimler-Benz to adjust to the development of production technology and the rapid changes in production volumes.

Impacts of Economic Regulation and the Wartime Economy

The regulation of production, specifically wartime regulation, had a considerable impact on the manufacturer-supplier relationship in the automotive industry. We focus on two important issues: the standardization of automotive components and experiences in military production.

[17] During a depression, production decreases, so the ratio of value added to sales decreases and the ratio of material purchased to sales increases, if the material cost remains constant. Thus, the decrease in the rate of material purchases suggests that the material costs were reduced more than the decrease of production.

Figure 2: Rate of Change against the Previous Year (Real Term)



Source: Author calculation from data in Table 3.

Economic regulation began with the "4-Years' Plan" in 1936, which aimed to allocate materials and resources preferentially to military production.[18] In particular, steel allocations after May 1937 made it difficult for carmakers to procure materials and parts. To cope with insufficient materials, the government demanded the automotive industry reduce the variety of automobiles for more efficient production and appointed Captain von Schell the General Plenipotentiary for the Automobile Industry (*Generalbevollmächtigter für das Kraftfahrwesen: GBK*) in November 1938 to enforce this. Under his supervision, the Technical Committee of the Economic Group of Motor Vehicle Industry (*Wirtschaftsgruppe Fahrzeugindustrie: Wigrufa*), the organization obligated to regulate the industry, managed to drastically reduce the variety of cars and trucks by March 1939.

Captain von Schell demanded standardization of automotive components.[19] Based on an urgent survey of the carmakers on the technical specifications of each component for the models they produced, the *Wigrufa* set up special working groups for each major component under the Technical Committee and appointed the leading supplier of each component as a representative of the working group. The groups forged tentative standardization plans, which were discussed at the extended meetings of the Technical Committee with the representatives of the working groups, related authorities, and the army. Even after the outbreak of the war in September 1939, the project was promoted until standardization was achieved for 102 major components at years' end. The date for introducing these standardized components was eventually set for April 1, 1941.

Table 4 shows the results of the standardization for the 47 components for which data are available. The total number of variations was reduced by almost 90 percent from 1,305 to 153. The Technical Committee expected increased efficiency and lower prices from the standardization, but was apprehensive that many small suppliers might be driven out from the market.

The Daimler-Benz delegate, Oberbaurat Fritz Schmidt, played a crucial role in the standardization process as chairperson of the extended meetings of the Technical Committee. As a result of his efforts, Daimler-Benz maintained almost the same product lines as it had for both cars and trucks, despite the drastic reduction in the number of variations. However, under the wartime economy, Daimler-Benz was allowed to produce only one car model, the smallest one, called 170V. Daimler-Benz confirmed in October 1940 that 61 sorts among the standardized components were used for the model 170V and that about the half of them

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[18] The description of the "4-Years' Plan" and the reduction of car models is based on Gregor, *Daimler-Benz in the Third Reich*, 69-78.

[19] The description of the standardization of parts and components is based on the documents in DaimlerChrysler Archiv, Bestand Kissel 9.31 (Wigrufa).

would be changed over to the standardized norms by the April 1, 1941 deadline.[20]

TABLE 4
Standardization of automotive parts and components

#	Item	# of Varieties before	#of Varieties after	Ratio after / before	Representative Firm
5	Battery	14	12	0.857	Pfalzgraf
6	Ignition Coil	16	5	0.312	Bosch
7	Ignition Distributor	87	13	0.149	Bosch
8	Switch Box	86	1	0.012	Bosch
9	Fuse Box	15	3	0.200	Bremicker
10	Fuse	5	3	0.600	Elektrotechnische Fabrik
11	Spark Plug	35	2	0.057	Bosch
12	Spark Plug Connector	11	5	0.454	Bosch
13	Glow Plug	19	1	0.053	Bosch
14	Starter Cable	5	2	0.400	Bosch
16	Light Bulb	269	30	0.111	Osram
18	Light Switch	2	1	0.500	Bosch
20	Dimmer Switch	7	2	0.286	Bosch
21	Winker Switch	38	2	0.057	Bosch
22	Off Switch	34	2	0.059	Bosch
23	Brake Light Switch	45	3	0.067	Bosch
24	Signal Button	22	1	0.045	Bosch
25	Starter Button	4	2	0.500	Bosch
26	Connector Outlet	10	1	0.100	Bosch
27	Handlight Outlet	9	2	0.222	Bosch
28	Dashboard Light	5	2	0.400	Osram
29	Horn	8	1	0.125	Westfälische Metallindustrie (Hella)
36	Carburetor	160	13	0.081	Deutsche Vergaser (Solex)
37	Fuel Injection Pump	8	7	0.875	Bosch
39	Fuel Pump	44	2	0.045	Deutsche Vergaser (Solex)

[20] DaimlerChrysler Archiv, Bestand Kissel 9.31, *Aktennotiz von Dir. Sailer am 4.10: 1940 über die Vereinheitlichung*.

42	Oil Filter	176	9	0.051	Mahle
43	Fuel Filter	42	4	0.095	Bosch / Frankfurter Armaturenwerk
56	Hydraulic Brake - Main Cylinder	102	8	0.078	Teves
56	Hydraulic Brake - Brake Cylinder	122	10	0.082	Teves
56	Hydraulic Brake - Brake Hose	45	6	0.133	Teves
56	Oil Brake - Brake Cable	150	32	0.213	Teves
57	Air Brake - Air Compressor	35	3	0.086	Knorr-Bremse
57	Air Brake - Brake Cylinder	70	7	0.100	Knorr-Bremse
57	Air Brake - Air Holder	40	5	0.125	Knorr-Bremse
57	Air Brake - Coupling Head	8	1	0.125	Knorr-Bremse
57	Air Brake - Manometer	12	2	0.167	Knorr-Bremse
57	Air Brake - Brake Valve	24	4	0.167	Knorr-Bremse
57	Air Brake - Pressure Regulator	5	1	0.200	Knorr-Bremse
57	Air Brake - Screwing	140	28	0.200	Knorr-Bremse
63	Disc Wheel	82	9	0.110	Hering / Bergische Stahlindustrie
66	Speed Meter	100	5	0.050	VDO
69	Oil Pressure Meter	25	3	0.120	VDO
70	Fuel Meter	4	1	0.250	VDO
71	Remote Thermometer	15	1	0.067	VDO
72	Watch	50	3	0.060	VDO
73	Tachometer	5	1	0.200	VDO
74	Odometer	1	1	1.000	VDO
	Total	**1305**	**153**	**0.117**	
	Average	47.04	5.57	0.21795	

Source: DaimlerChrysler Archiv, Bestand Kissel 9.31, Wirtschaftsgruppe Fahrzeugindustrie, *Vereinheitlichungsbeschluß*.

The American style of production, which was the underlying model for production in the 1920s, is characterized by the mass production of small numbers of car models and standardized, compatible components.

In Germany in the 1920s, the effects of this rationale were limited because neither a reduction in the number of car models nor a standardization of components was achieved. These were accomplished in a burst of activity at the end of the 1930s under heavy pressure from the government, but remained without substantial results because of the outbreak of World War II. However, we can argue that this standardization project contributed to the later development of the automotive industry: all carmakers and their major suppliers participated in the standardization project, which included the exchange of technical information among component suppliers as well as between the suppliers and the carmakers.

With regard to Daimler-Benz, which was engaged in the large-scale production of cars until 1942, we can assume that the company continued to introduce standardized components, which may have been used when production restarted after the war.[21] Daimler-Benz AG switched to wartime production at the end of March 1940, but continued to produce cars until 1944, although production decreased drastically from 27.000 cars in 1939, to 4.000 in 1942, to almost zero after 1943.[22] In addition, between 1939 and 1944 there was a 50 percent reduction in truck production, which was limited to the military demand. The only car model produced under the wartime economy was the 170V, which had been in production since 1936 and was selected at the resumption of car production in 1946.

During wartime, aircraft engines replaced automobiles as the main product. Daimler-Benz became a center for production of aircraft engines as the leader of the Manufacturers' Ring (*Fertigungsring*), a new obligatory grouping of the producers of military products.[23] The president of the subsidy established in Genshagen near Berlin in 1936 to produce aircraft engines (Daimler-Benz Motoren-GmbH), Director Karl C. Müller, was appointed the leader of this ring in 1941. Daimler-Benz was continuously in charge of supervising the ring's member firms.

When serious quality problems with some important engine parts occurred in 1942, Director Fritz Nallinger, who was in charge of research and technology, remarked at the board meeting June 30th and July 1st:

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[21] According to an internal agreement in June 1940, "after the end of the war, the cars of the model 170V ... should be produced in observance of the regulations of the standardization of parts and components." DaimlerChrysler Archiv, Bestand Kissel 9.31, *Vereinheitlichung Typ 170V Pkw und 170V Kübelsitzwagen v. 14.06.1940*.

[22] Kruk and Lingnau, *100 Jahre Daimler-Benz AG*, 332.

[23] The manufacturers' ring for aircraft engines was formed in September 1941 before the institutional establishment of these rings after April 1942. See Martin Pesch, *Struktur und Funktionsweise der Kriegswirtschaft in Deutschland ab 1942—unter besonderer Berücksichtigung des organisatorischen und produktionswirtschaftlichen Wandels in der Fahrzeugindustrie* (Cologne, 1988), 51ff and 104ff, for details of the manufacturers' rings.

> We have to bring up and look after all of our suppliers, additionally to our own work, that is permanently not feasible. Such an insufficiency of the suppliers means the greatest difficulties in producing our engines. Our quality inspectors travel every month to the suppliers to monitor the product quality constantly and in detail in their factories. We built up a special group for it, which works out instructions for manufacturing and controls its implementation at the suppliers.[24]

His statement suggests that Daimler-Benz systematically provided the suppliers of engine parts with detailed technical advice and instructions, though somewhat unwillingly. It is noteworthy that the target of this policy included the suppliers of specialized components, such as bearings and pistons.

Daimler-Benz formally introduced double-sourcing (purchasing the same kind of parts from two suppliers) and the cooperative design of aircraft engine parts with suppliers at the beginning of the 1940s. We cite as evidence the protocol of the meeting of the top managers of Daimler-Benz with the representatives of the leading forging industry firms June 17, 1941:

> To open the meeting, Director Nallinger stated that the relationship between Daimler-Benz and the forging companies must be closer, so that the experiences of the latter might be applied more usefully than before in designing the drawings. The close cooperation with the light metal foundries was described as a good example.
>
> The current way that the engine manufacturer designs the drawings of forged parts from the beginning is essentially wrong. We would appreciate it, if we could give a completed design of the engine, on which we mark the points where we require additional treatments (...), and they would make corresponding drawings of forged parts as soon as possible.
>
> All the representatives of the forging firms absolutely agreed with this proposal. How to strengthen the cooperation was discussed and determined on the later meeting. The representatives of the forging firms agreed with us completely in that the best way to form forged parts is to have the forging firms propose us the form of these parts according to our completed design. In the cooperation of the forging companies with the other engine manufacturers, it proved to be inappropriate that the latter themselves draw up designs of parts and then give them to various suppliers to work accordingly.

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[24] DaimlerChrysler Archiv, Bestand Kissel 1.15, *Protokoll der Vorstandssitzung in UT am 30.6/1.7.42*.

> It was agreed that in the future Daimler-Benz gives the forging companies completed designs when new parts for a new engine model are to be made and that the forging companies then make corresponding proposals for the drawings of these parts.
>
> In the future, the completed designs will be sent by the Purchasing Department in only 2 copies to 2 forging companies, which are the most suitable to produce the part. (...) Both suppliers then return proposals for the designs of parts to Daimler-Benz, according to which the binding designs of parts are drawn up.[25]

The key points of the agreement were to fix two suppliers for each major type of forged part and to introduce cooperative design with these suppliers instead of design by the engine manufacturer. In fact, two suppliers were determined for each of 8 sorts of forged engine parts, as shown in Table 5. All of the nominated suppliers were large steelmakers in the Ruhr area. Moreover, the first paragraph of this citation suggests that a similar agreement was already in place with the light metal foundries.

TABLE 5
Suppliers of aircraft engine parts (forged parts) in wartime (according to the Agreement of June 17, 1941)

Items	First Supplier	Second Supplier
Piston Rods	DEW	Bochumer Verein
Gearwheels	DEW	Zapp (Krupp)
Propeller Shafts	DEW	Böhler
Long Shafts	DEW	Röchling-Buderus
Supercharged Drive Wheels	DEW	Bochumer Verein
Other Engine Gearwheels	DEW	Bochumer Verein
Small Parts above 400g	Schöneweiss	Engels
Small Parts below 400g	Engels	Herder

Source: DaimlerChrysler Archiv, Bestand Kissel 1.33, Technische Protokolle, *Schmiedebesprechung v. 17.6.1941.*

We believe that this double-sourcing policy was introduced into car production in wartime. It is suggested by the spare parts suppliers' list shown in Table 6. This is a partial reconstruction of the suppliers' list of

[25] DaimlerChrysler Archiv, Bestand Kissel 1.33, *Aktennotiz Nr. 2710 betreff. der Besprechung in Untertürkheim am 17.6.41 (Schmiedebesprechung).* This meeting took place at the Daimler-Benz headquarters, in which 7 representatives of the 7 leading firms in the industry, among which 3 persons also represented the regulatory commission of the industry, and 13 top managers of Daimler-Benz, including Director Nallinger, participated.

the original fitting parts for the car model W136 (170V), the only model manufactured during wartime, from the list of the major spare parts. Such a reconstruction was needed to restart the production of this model after the war because almost all the documents on parts purchasing were lost in the war. Listed parts were limited to those for which the documents had to be prepared immediately for the inquiry to the suppliers, so that the list is far from complete, but we assume that it accurately reflects the overall tendency.

According to Table 6, among 57 sorts on the list, 38 sorts were purchased from one source but 19 sorts had multiple (mainly double) sources, so the double- or multiple-sourcing was applied to just one-third of the purchased parts and components. Specialized components such as carburetors, electric engine parts, buffers, brakes, clutches, handles, and radiators were typically purchased from a sole supplier, while forged parts and press parts for the chassis and the rear wheel system tend to have had double or multiple sources.

A question may be raised as to why Daimler-Benz adopted the double-sourcing strategy instead of concentrating the purchase of each part and component on a sole supplier during wartime, when the concentration of production in a few firms was promoted to rationalize military production.[26] One reason would be the risk of bombing. It would be risky to concentrate on a sole supplier because the parts supply would be stopped if the supplier's plant was destroyed.[27] There are other factors that could interfere with the parts supply, such as lack or misallocation of production materials, which made double-sourcing necessary to secure the parts supply. Moreover, for the case of aircraft engine parts, we assume that the double-sourcing was expected to promote competition in Research and Development (R&D) between the suppliers, for the cooperative design was agreed on at the same time.

To sum up, it can be assumed that Daimler-Benz introduced double-sourcing wherever it was feasible and intensified technical advice to various suppliers including the manufacturers of specialized components, to secure reliable delivery and sufficient quality of purchased parts under the conditions of high risk and material shortages in the wartime economy.

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[26] Compare R. J. Overy, *War and Economy in the Third Reich* (Oxford, U.K., 1994), 358-359.

[27] With regard to the purchase of aircraft engine parts, President Kissel argued against the concentration of sources, given the risk of bombing. DaimlerChrysler Archiv, Bestand Kissel 1.14, *Protokoll der Vorstandssitzung am 11.12.41.*

TABLE 6
Reconstructed list of suppliers for W136 (170V)

Parts Group	#	Item	Last Supplier	Alternative Supplier	# of Last Suppliers	# of Alternative Suppliers	Total # of Possible Suppliers	Notes
Engine Parts	1	Crank Housing	In-house (Mannheim)	Maschinenfabrik Esslingen	1	1	2	
	2	Sump (Oil Pan)	Ritter Huettenwerk Bodenwoehr		2	0	2	
	3	Gear Case Cover	Mahle		1	0	1	
	4	Valve Guide	Schwaebisches Huettenwerk		1	0	1	
	5	Cylinder Head	Eisenwerk Erla	In-house (Mannheim)	1	2	3	
	6	Flywheel	Winter	Maschinenfabrik Esslingen Bosch	1	2	3	
	7	Piston complete	Mahle	Stotz Alum.Giesserei Nuernberg	1	1	2	
	8	Exhaust Bender	Gebr. Gienanth		1	0	1	
	9	Coolant Pump Case	Stockey & Schmitz		1	0	1	
	10	Thermostat Case	Rautenbach		1	0	1	
	11	Intake Manifold	Eisengießerei Saargmünd		1	0	1	
	12	Crankshaft	DEW	Alfing?	1	1	2	
	13	Wheel Rim	Hay		1	0	1	
	14	Bearing for Crankshaft	Glyco-Metall		2	0	2	
	15	Carburetor	Braunschweigisches Huettenwerk Deutsche Vergaser (Solex)		1	0	1	new supplier, in-house production?

	16	Screw Gear	Bosch	Ferrozell	1	1	2	
	17	Coolant Pump Shaft	Witzemann		2	0	2	where to purchase, in-house production?
	18	V-Belt	Sueco Continental		2	0	2	
	19	Air Filter	Semperit Knecht		1	0	1	
	20	Electric Equipments for Engine	Bosch		1	0	1	
Frame Parts	21	Steel Tube Parts	Kammerich	Benteler	1	1	2	in the future in Sindelfingen?
	22	Cross Member	Thelen		3	0	3	
Front Spring and Rear Spring	23	Leaf Spring	Faulstroh Siegas Plate Hoesch		3	0	3	
	24	Spiral Spring	Röchling Rheinmetall		2	0	2	
	25	Shock Absorber	Hoesch Fichtel & Sachs		1	0	1	
Rear Wheel Drive	26	Rear Axle Housing (right and left)	Mag		2	0	2	
	27	Rear Axle Housing Cover	Winter Bergische Stahlindustrie		1	0	1	
	28	Differential Gear Box	Meier & Weichert		1	0	1	
	29	Bearing Body	Winter	Stotz Mag	1	3	4	

				Allweiler			
	30	Support Tube	Schwinn Bochumer Verein Eisenwerk Wanheim		3	0	3	processing in Untertürkheim, in-house production?
	31	Bevel Gear	DEW		1	0	1	in-house production?
	32	Cardan Shaft	Kammerich Presswerk Reisholz		2	0	2	in-house processing?
	33	Running Wheel	Hering Kronprinz	Lemmerz	2	1	3	
Brake	34	Brake Drum	Chillingworth Andersen		2	0	2	in-house production in Sindelfingen?
	35	Brake complete	Teves		1	0	1	Teves totally destroyed
	36	Brake Lining	Kirchbach'sche Werke Emero Semperit	Textar Danco	3	2	5	
Gear	37	Gear Box	Ritter Allweiler		2	0	2	
	38	Gear Lever	Henkels		1	0	1	
	39	Gear	ZF		1	0	1	partially in-house before, now totally?
Clutch	40	Clutch complete	Fichtel & Sachs		1	0	1	in-house production?
	41	Clutch Lining	Kirchbach'sche Werke Emero	Textar Danco	3	2	5	

			Semperit					
Pedal	42	Brake-Pedal	Raspe		1	0	1	in-house production?
Steering	43	Steering complete	ZF		1	0	1	in-house production?
	44	Steering Gear Housing	Bergische Stahlindustrie		2	0	2	
	45	Steering Wheel	Stockey & Schmitz Bosch	Petri	1	1	2	
Exhaust System	46	Muffler	Eberspächer		1	0	1	production in Sindelfingen
Radiator	47	Radiator	Behr		1	0	1	
Frame Accessory	48	Bumper	Klein		1	0	1	in-house production?
Light Equipment	49	Battery	Hoppecke? Varta		2	0	2	
Lubrication	50	Central Lubrication	Willy Vogel		1	0	1	
Ball Bearing	51	Ball Bearing	Vereinig. Kugellagerfabriken Kugelfischer		2	0	2	
Instruments	52	Tachometer	Veigel	VDO	1	1	2	
	53	Fuel Meter	Eckardt		1	0	1	
	54	Oil Manometer	Eckardt		1	0	1	
	55	Clock	Mauthe Kienzle		2	0	2	
	56	Wiper	SWF		1	0	1	
	57	Winker	SWF		1	0	1	

Notes: partial reconstruction of the purchasing documents, which were lost in bombing September 5th 1944, from the order list of spare parts; question marks in the Table are in the original document.

From the Economic Recovery to the High Growth (from 1945 to the 1960s)

The West German automotive industry recovered rapidly from damages during the war. Annual car production including station wagons increased remarkably from fewer than 1,300 in 1945 to more than 300,000 in 1952 and broke the prewar record of 277,000 in 1938. The carmakers extended car production rapidly in the 1950s, such that car production in the 1960 was more than 8 times that in 1950. Measured by the industry production index, the growth rate of the automobile production in the 1950s was more than twice the average manufacturing sector level and was ranked at the top of the investment goods industries. As shown in Table 1, cars rapidly took over in West Germany after 1950. Thus, in the late 1950s German society experienced full motorization together with high economic growth.

Daimler-Benz restarted automobile production just after the war. The production of wartime model trucks began, at the request of the occupation army, in May 1945 at the Mannheim plant and in July 1945 at the Gaggenau plant (1,037 trucks that year), followed by the car production at the Untertürkheim plant in 1946 (214 cars that year).[28] The car Model 170V, which was produced then, was the last wartime model.

The recovery of Daimler-Benz in car production was remarkable. As early as 1950, they produced more than 30,000 cars, considerably exceeding the 1938 prewar peak. Daimler-Benz car production grew rapidly during the 1950s until it exceeded 100,000 in 1959 and 200,000 in 1967. With increased production, the number of total suppliers also increased, from 12,643 in 1950 to 17,760 in 1961. These suppliers included not only material and parts suppliers, but also the suppliers of all kinds of "unproductive" goods and services such as stationary or catering services; we roughly estimate the number of material and parts suppliers by focusing on suppliers with annual sales of more than 20,000 DM to Daimler-Benz. The number of material and parts suppliers estimated in this way increased from 1,180 in 1950 to 3,195 in 1961 (see Table 7).[29] Moreover, the rate of expenditures for material and parts as a portion of

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[28] The war destroyed 70% of the Untertürkheim plant (car assembly, then aircraft engines), 80% of the Gaggenau plant (heavy trucks), and 85% of the Sindelfingen plant (bodywork), but the damage of the Mannheim plant was limited to 20%. See Kruk and Lingnau, *100 Jahre Daimler-Benz AG*, 159.

[29] This estimate is supported by the 1962 report of Director Otto Jacob (purchasing) in which he states that "3,500 among around 17,000 suppliers are very closely related to our production." DaimlerChrysler Archiv, Bestand Reden Jacob, *Beispiele erfolgreicher Unternehmensplanung, Rede am 29./30.11.1962*: 10.

total production cost remained stable around 65 percent from 1956 to 1961, suggesting that the double-sourcing of parts persisted into the 1950s.[30]

TABLE 7
The number of suppliers of Daimler-Benz (DB) 1950-1961

Sales to DB*	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Above 1,000	60	96	132	107	141	201	219	217	256	279	309	-
500 - 1,000	67	91	68	94	75	108	123	119	155	166	188	-
100 - 500	271	368	410	382	399	593	652	643	762	833	906	-
50 - 100	259	324	328	292	361	488	525	508	536	620	652	-
20 - 50	523	633	644	667	741	845	859	873	937	1078	1140	-
Below 20	11463	11562	11807	11720	12139	12260	12560	12280	12742	13395	13363	-
Together	12643	13074	13389	13262	13856	14495	14938	14640	15388	16371	16558	17760

Note: * in 1,000 DM.
Sources: Daimler-Benz AG, Volkswirtschaftliche Abteilung, *Das Verhältnis des Großbetriebes zu seinen mittelständischen Zulieferern*, mimeo. (Stuttgart, 1962); *Id.*, *Das Großunternehmen und der industrielle Mittelstand*, mimeo. (Stuttgart, 1962).

In the early postwar period, the top management of Daimler-Benz gave priority to in-house production. According to a notice in December 1948 by Director Otto Hoppe, who stood proxy for President Wilhelm Haspel during his banishment ending in 1947, "Outsourcing of parts and components that can be produced in-house should be allowed in general only when the productive capacity of the own plants is full in use."[31] Therefore, the remarkable expansion of outsourcing in the 1950s may be attributed to achieving the limits of internal production capacity with rapidly increasing demand. According to a research report around 1963, about 1,000 sorts of parts were switched from in-house production to outsourcing in the second half of the 1950s, which is 10 times more than the number of parts switched to in-house production during the same

[30] Daimler-Benz AG, Volkswirtschaftliche Abteilung, *Das Verhältnis des Großbetriebes zu seinen mittelständischen Zulieferern* (Stuttgart, 1959), 4, and *Das Großunternehmen und der industrielle Mittelstand* (Stuttgart, 1962), 9.
[31] DaimlerChrysler Archiv, Bestand K. C. Müller, Einkauf (Lieferfirmen) II; *Schreiben vom Dir. Dr. Hoppe am 20.12.1948*. In addition, at Volkwagen in 1957, a similar notice was sent from the president to the board members. Stiftung AutoMuseum Volkswagen, Bestand Vorstand Einkaufsleitung, *H. Nordhoff, Aufträge/auswärtige Lieferanten (8.3.1957)*.

period. The main reasons for switching to outsourcing were the lower cost and restrictions of internal production capacity.[32]

In expanding the outsourcing of parts and components, the carmakers consulted with the suppliers on their plan for production expansion early enough (9 to 12 months in advance) so that the suppliers could secure the necessary production capacity, and requested them to increase production capacity according to a demand estimation.[33]

In a contract on the supply and licensing of the transmission system with ZF (Zahnradfabrik Friedrichshafen), Volkswagen announced, 9 months before serial production, a minimum order volume for 1.5 years and proposed a loan for capital investment up to 1 million DM.[34] In a contract between Volkswagen and Fichtel & Sachs for the exclusive supply of a clutch system, it was agreed that the former provide the latter an estimation of the monthly order volume for at least 1.5 years at least 9 months before serial production and that the depreciation of the capital investment be considered in the price calculation.[35] As these cases suggest, the carmakers had to commit to a long-term relationship, now that they required suppliers to secure and expand production capacity for them for a certain period.

The carmakers' request to the parts suppliers is demonstrated in the documents of a supplier. Kronprinz AG, one of the leading wheel makers in Germany, which expanded its production capacity after the 1950s in accordance with carmakers' requests, asked the parent company

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[32] Werner Reich, *Bericht über meine Untersuchung bei der Daimler-Benz AG im Rahmen einer Branchenuntersuchung Automobilindustrie* (mimeograph, Daimler Chrysler Archiv, 1963?), 133.

[33] Stiftung AutoMuseum Volkswagen, Bestand Vorstand Allgemein, *Interne Mitteilung von Paulsen an Nordhoff vom 25.3.59*. A model is found in a prewar contract of this company. In the contract between Volkswagen and Boge & Sohn in October 1941, with regard to the supply of shock absorbers after the end of the war, the estimation of monthly orders was shown for 3 years, stipulating that "we conclude this contract already at this time in order to secure the production capacity of the latter (Boge) for the demand of the former (Volkswagen) and to enable the latter (Boge) to plan accordingly in advance." Mannesmann-Archiv, Bestand M17.776 (Boge & Sohn), *Liefervertrag mit VW v. 15.10.1941*.

[34] Stiftung AutoMuseum Volkswagen, Bestand Geschäftsleitung, *Korrespondenz Dr. Knott (Rechtsabt.) an Nordhoff v. 5. Juli 1950*. This document is the final proposal of the contract to President Nordhoff. The loan was to be approved on security, with an interest rate of 5% per year, to be paid back by deducting 40 DM each month from the unit price.

[35] Stiftung AutoMuseum Volkwagen, Bestand Vorstand 1966, *Besprechungsbericht v. 21.10.66 betr. Wanderer-Schaltkupplung*. In response to this proposal, Fichtel & Sachs asked for the assurance of no switching to in-house production and the advance payment of a part of the necessary capital investment.

(Mannesmann group) for more financial support for further investment in 1962:

> Our greatest concern is the investment. The necessary amount of investment for 1962 is estimated to be 16 million DM, but only 10 million DM have been approved for the moment. We make efforts to manage it with 13 million if necessary. We must increase our wheel production from 13,000 to 18,000 units per day in any case, in order to survive the cost competition and not to lose the business with the carmakers. For example, the Bochum plant of Opel, which is now being set up, will purchase our wheels, but they would prefer producing the wheels in-house as Volkswagen does, if we could not come through with their requests.[36]

In the early postwar years, carmakers were seriously troubled by delivery and quality problems with parts and components. As Daimler-Benz documents reveal, one serious quality problem was revealed after another from 1949 to 1951, even with the first-class suppliers of specialized components, such as R. Bosch, A. Teves, Goetze, Eugen Klein, ZF, and Carl Freudenberg.[37] Delayed delivery and poor quality became almost everyday incidents at the nationwide nadir of production materials in 1951.[38] According to Production Planning Division documents, shortages and parts and components defects were found and reported almost daily from May 16, to December 10, 1951.[39]

We can assume that these troubles even with deliveries from top suppliers were attributable to the overall difficulty in procuring high quality material and to the difficulty of expanding production capacity at the same pace as increase in demand. In fact, delayed deliveries were often reported even for the parts produced in-house.[40] As discussed, there were similar troubles in the prewar period, but then Daimler-Benz

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[36] Mannesmann-Archiv, Bestand M19.031 (Kronprinz Schriftswechsel), *Aktennotiz vom 21.03.62 betr. Besprechung bei Kronprinz mit den Herren Dr. Albert und Goosens.* When Volkswagen switched the source of the wheels to in-house production, it "kept the promise" and gave Kronprinz an alternative order of steel tubes; Mannesmann-Archiv, Bestand M19.031, *Zusätsliche Bemerkungen zur Aufsichtsratsitzung am 27.Okt. 1959.*

[37] DaimlerChrysler Archiv, Bestand K. C. Müller, Einkauf (Lieferfirmen) II, *Fahrzeugteile ohne Typenbezeichnung I.*

[38] The postwar German economy experienced remarkable shortages of various materials, especially steel, which peaked in 1951 and continued to 1952. See Wellhöner, *Weltmarkt—"Wirtschaftswunder,"* 161ff.

[39] DaimlerChrysler Archiv, Bestand K. C. Müller, Einkauf II 4, *Aufstellung anfallender Mehrzeiten wegen Fehlens bzw. Verwendung ungeeigneten Materials.* These lists contain many parts produced in-house.

[40] DaimlerChrysler Archiv, Bestand K. C. Müller, Einkauf II 8, *Brief von der Werksleitung Sindelfingen an Dir. Müller v. 15.8.1951*; *Korrespondenz zwischen Betriebsdirektor Held (Sindelfingen) und Dir. Müller in August 1954.*

coped with these troubles mainly by switching to in-house production or to another supplier. However, after 1950, the carmakers could hardly immediately switch to in-house production or another supplier, because any surplus in production capacity was used up either in-house or at the alternative suppliers due to the rapid increase of demand for cars. Instead of switching to alternative sources, the carmakers promoted the double-sourcing of parts and intensified the relationship with the suppliers, strengthening the control over and direction of the suppliers. These were the same strategies used in wartime.

The following citation shows clearly that Volkswagen promoted the double-sourcing of parts in the 1950s and why; it is part of a letter from the director of purchasing, J. Paulsen, to President Heinrich Nordhoff in August 1957:

> The steady increase of our production forced the forging companies into making considerable capital investment, additionally to the already achieved rationalization. Some large firms had no difficulties with it, but we found considerable difficulties at middle-sized suppliers. They asked us to call in a second supplier, since they reached the limit of capacity and rationalization. Thus sooner or later we had to come to terms with calling in a second supplier.
>
> Another important factor to call in a second supplier was the security of parts supply. The steady and remarkable increase of our production did not allow us to work with a sole supplier. In all cases, we had to call in a second supplier as far as possible, beginning with a smaller amount. We have chosen this way for not only forged parts, but also for all the other parts. We had to allow an exception only for the cases in which this way was not feasible because the parts had been patented or the supplier had no competitors in the whole country. (...) This policy is supported by the large amount of our serial production with regard to both price and quality. Thus since several years we have gone over to looking for second suppliers for our mass production and have found them too.
>
> In shifting orders to a second supplier, we made sure in all cases that the existing production facilities [of the first supplier], which had been built trusting in the promises from us, be fully used. The second suppliers, which start slowly and should receive only 20-25% of the whole orders in general, cover only the increase of our production.[41]

Director Paulsen also reported that double-sourcing weakens the bargaining power of the dominant supplier, that it was limited to cars as it

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[41] Stiftung AutoMuseum Volkswagen, Bestand Vorstand 9/1 Einkaufsleitung, *Brief von Paulsen an Nordhoff vom 6.8.57.*

had not yet been introduced into bus and truck production, and that this strategy was effective with regard to the price, quality, and delivery of parts. It is noteworthy that double-sourcing was applied not only to forged parts, but to as many types of parts as possible.

In addition, for Daimler-Benz we found evidence that double-sourcing became prevalent before 1960.[42] Moreover, historical documents from a leading supplier of an engine part suggest that this strategy was already common to German carmakers in the 1950s.[43]

Another measure Daimler-Benz took to address the parts quality and delivery problems was to intensify their relationship with the suppliers, to strengthen their control over and direction to them. According to a 1956 report by Director Otto Jacob, the managers of the Purchasing Department were obliged to gather supplier evaluation data (such as the reliability of delivery, the defect rate, and the overall evaluation of the relationship) from the related departments and to check the suppliers constantly by visiting the plants and inspecting financial data.[44] Moreover, with regard to particularly expensive and important parts and components, they had to examine the design and production process, and calculate the cost on their own. A 1962 document reveals that the purchasing managers were required to continuously announce Daimler-Benz production plans to the suppliers so they could keep in step with Daimler-Benz.[45] Thus, since the mid-1950s Daimler-Benz made close information exchanges with the suppliers a basic principle of purchasing management.

The dependence of the suppliers on Daimler-Benz (the ratio of sales to Daimler to total sales) increased, according to an internal survey, from an average of 7.5 percent in 1954 to 12.5 percent in 1959.[46] However, this percentage is still too low to be regarded as a high level of dependence. Therefore, these data suggest that many suppliers managed to diversify

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[42] "We work with at least two suppliers in almost all the fields." DaimlerChrysler Archiv, Bestand Könecke 59, *Protokoll über die technische Vorstandssitzung am 17. Mai 1960*.

[43] Okamuro, "Buhin torihiki ni okeru kyoso to kyocho: Kodo seichoki Doitsu no jirei," 69-70.

[44] DaimlerChrysler Archiv, Bestand Reden Jacob, *Automatisierung unserer Einkaufsarbeit*, 11-12.

[45] DaimlerChrysler Archiv, Bestand Reden Jacob, *Beispiele erfolgreicher Unternehmensplanung*, 10.

[46] Daimler-Benz AG, *Das Großunternehmen und der industrielle Mittelstand*, appendix. The 135 firms in the survey are a random sample from the suppliers with less than 1,000 employees located in two federal states, Nordrhein-Westfalen and Baden-Württemberg, where most suppliers were concentrated.

their transactions, avoiding dependence on a certain carmaker in the face of a rapid increase in the carmakers' orders.[47]

In 1960, the carmakers extended the contract term with the suppliers from 6 months to one year.[48] For the carmakers, the longer contract term had the advantage of securing the parts supply for a longer period, while providing the suppliers with the merits of stable demands. Daimler-Benz maintained a stable relationship with most suppliers at the beginning of the 1960s and carried out "cooperative design"[49]: About 80 percent of the suppliers manufactured the parts according to designs by Daimler-Benz, but in many cases they "bring in their original ideas based on their experiences and so do not work just as indicated in the designs of Daimler-Benz."[50] Even if they worked exactly as Daimler-Benz indicated, it would take at least 1 or 2 years to switch, considering the specific machines, equipment, and tools used.[51]

How did the carmakers cope with the quantitative and qualitative extension of purchasing management? In 1948, Daimler-Benz appointed Otto Jacob, who had been in charge of purchasing management at Opel, the director with the same mission. He remained in this position until his retirement in 1974 and promoted the systematic and efficient

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[47] In this regard, the case of Hasenclever, a supplier of cylinder heads, would be illustrative. This firm had had business relations with Volkswagen since the early postwar days. It was the main supplier of the two suppliers of cylinder heads and showed much higher product quality. When Volkswagen demanded it increase the production "by several times," it rejected this request since it created an excessive level of dependence, and Volkswagen eventually decided to produce them in-house. However, both parties concluded a "Gentlemen's Agreement" that they continue the business with cylinder heads until Hasenclever secured an alternative customer for their products. See DaimlerChrysler Archiv, Bestand K. C. Müller, Einkauf II, *Aktennotiz Nr. 640/54 v. 6.9.1954*.

[48] Okamuro, "Buhin torihiki ni okeru kyoso to kyocho: Kodo seichoki Doitsu no jirei," 69; DaimlerChrysler Archiv, Bestand Reden Jacob, *Beispiele erfolgreicher Unternehmensplanung*: 9; DaimlerChrysler Archiv, Bestand Auto Union 28, *Aktennotiz betr. Einkaufsabschlüsse vom 4.1.1961.*

[49] According to Reich, *Bericht über meine Untersuchung bei der Daimler-Benz AG*, 44 out of 50 firms in a random sample from the list of suppliers of Daimler-Benz maintained a stable and continuous relationship with Daimler-Benz during the sample period from 1955 to 1961. A press release by Volkswagen in 1961 included a statement that about 2,000 firms among 3,600 suppliers of parts and materials were long-term suppliers. See Stiftung AutoMuseum Volkswagen, Bestand Vorstand Allgemein, *Information für Pressekonferenz vom 15.9.1961.*

[50] Reich, *Bericht über meine Untersuchung bei der Daimler-Benz AG*, 121. The rest (about 20%) were the suppliers of the catalogue goods.

[51] Ibid., 139.

reorganization of purchasing management by producing many guidelines, manuals, and the related forms.[52]

The increased efficiency of purchasing management is revealed in the disposition of personnel at the Gaggenau plant at the beginning of the 1960s.[53] Of the 268 employees in the purchasing division, 26 were allocated to the Purchasing Department (*Einkauf*) for negotiating and contracting with suppliers, 74 to the Procurement Department (*Beschaffung*) in charge of daily orders and deliveries after the contracts, and 166 to the Administration Department (*Verwaltung*) controlling stock after delivery. Most members of the Administration Department were blue-collar workers. Among 26 members of the Purchasing Department, there were 15 persons, including 6 secretaries, who were assigned to the purchasing of production materials, so that in fact only 9 employees took charge of negotiating and contracting with suppliers of more than 25,000 parts and materials. We assume that it was enabled by the use of guidelines and manuals, good coordination with divisions such as design and production control, and last but not least, the routinization of tasks through the stabilization of the relationship.

As discussed, the full development of motorization required that carmakers dramatically expand outsourcing, and it became crucial for them to secure a stable supply of certified parts and components. The carmakers extracted huge capital investments from suppliers by announcing long-term demand estimates in advance and occasionally providing them with financial support to persuade them to make greater investments. Moreover, in the 1950s, the carmakers promoted the double-sourcing of parts and intensive relationships with suppliers, including cooperative design. The contract term was extended in 1960, establishing a stable relationship. This trend applied to all categories of suppliers. Now that the carmakers required the suppliers to invest in and secure production capacity for them, it became difficult to switch purchasing sources immediately, making stable and intensive relationships with suppliers necessary.

A Comparison with the Japanese Evidence

Let us now turn our attention to the history of the Japanese automotive industry and the development of the supplier network. We describe the

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[52] From 1948 to 1956, 102 guidelines and manuals as well as 130 related forms were created. The number of guidelines and manuals further increased to 157 in 1962, and 191 in 1968. See DaimlerChrysler Archiv, Bestand Reden Jacob, *Automatisierung unserer Einkaufsarbeit*, 9; *Beispiele erfolgreicher Unternehmensplanung*, 12; *Das Beschaffungswesen im Hause Daimler-Benz AG*, 11.

[53] DaimlerChrysler Archiv, Bestand Reden Jacob, *Beispiele erfolgreicher Unternehmensplanung*, appendix.

Japanese evidence based on some recent Japanese studies, mainly focusing on Toyota as representative of the Japanese production system.

The initial stage of the Japanese automotive industry was dominated by the knockdown (KD) production of foreign cars. Ford, General Motors, and Chrysler set up plants in Japan in the 1920s and assembled imported parts. Although there were many small parts manufacturers for the machinery industry, including the suppliers of spare parts for these KD or imported cars, the automotive parts industry was still underdeveloped and troubled by poor quality and high cost. This is the reason that both Toyota and Nissan produced most parts in-house or used imported parts at the onset of production.[54]

The July 1936 Motor Vehicle Manufacturing Act (*Jidosha Seizo Jigyoho*) was a turning point in the development of the prewar Japanese automotive industry.[55] It aimed to protect and promote the "domestic production" of motor vehicles and their parts for military reasons and drove foreign carmakers from Japan. After this Act, both the number of motor vehicles produced and the production of motor vehicle parts reached their peak in 1941, the last year before the war. Then, under wartime regulation and the mobilization of military production, both carmakers and parts suppliers had to switch production from motor vehicles to military products, specifically aircraft engines.

The Guidelines for the Development of Machinery and Steel Industries (*Kikai Tekko Seihin Kogyo Seibi Yoko*), released in December 1940, also had a significant impact on the automotive industry. This guide had three main purposes: to categorize the final assemblers, suppliers of special components and other suppliers (subcontractors); to establish and fix the relationship between final assemblers and selected parts suppliers, which would enable direct intervention from the former;

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[54] Kazuo Wada, "The Emergence of the 'Flow Production' Method in Japan," in: *Fordism Transformed: The Development of Production Methods in the Automobile Industry*, ed. Haruhito Shiomi and Kazuo Wada (New York, 1995), 18-19; Hirofumi Ueda, "The Subcontracting System and Business Groups: The Case of the Japanese Automotive Industry," in *Beyond the Firm: Business Groups in International and Historical Perspective*, ed. Takao Shiba and Masahiro Shimotani (New York, 1997), 215-42; Juro Hashimoto, *Nihon kigyo shisutemu no sengoshi* [The Postwar History of the Japanese Corporate System], ed. Takao Shiba and Masahiro Shimotani (Tokyo, 1996), 212; Hirofumi Ueda, *Senjiki nihon no shitauke kogyo* [Subcontracting Industry in Wartime Japan] (Tokyo, 2004), 284. While Nissan sought to produce everything in-house from the beginning, Toyota at first tried to use domestic suppliers. However, poor quality of parts soon forced it to switch to in-house production and to imported parts.

[55] Ueda, "The Subcontracting System and Business Groups: The Case of the Japanese Automotive Industry,"218; Ueda, *Senjiki nihon no shitauke kogyo*, 282-284.

and to promote mutual commitment between the parties.[56] Thus, these guidelines should have increased the efficiency of military production by establishing a close and intensive supplier network.

However, the guidelines did not seem to have achieved the overall aim, for neither party was interested in a government-imposed inflexible relationship. The critical shortage of materials in wartime resulted in scrambles for available suppliers and in serious opportunistic behavior by both parties.[57] Another problem was that the carmakers were not favored in the assignment of suppliers and so they had a hard time finding and keeping good suppliers, in part, because the priority in military production was on aircraft, as noted, and because the government tried to foster parts suppliers that produced compatible parts available to all carmakers.[58]

The wartime experiences in the aircraft industry may have played an important role in the development of the production system. Under pressure to increase efficiency with restricted resources, aircraft engineers introduced the assembly-line system into the production of aircraft engines and also managed to improve the internal parts supply. Moreover, we find one of the origins of the "approved drawing" of parts (the assembler approves the suppliers designs) in the 1930s aircraft industry, which may have had a direct influence on the postwar automotive industry.[59]

After the end of the war and military production, when engineers suddenly lost their jobs, many were then employed by the carmakers.[60] In this sense, Wada concluded that the "production methods at the automobile companies were strongly influenced by the wartime experiences at the aircraft companies."[61] The military industries,

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[56] Ueda, "The Subcontracting System and Business Groups: The Case of the Japanese Automotive Industry," 219-220.

[57] Hashimoto, *Nihon kigyo shisutemu no sengoshi,* 214.

[58] The Ministry of Trade and Industry examined the status quo and future perspectives of the compatibility of automotive parts in December 1940 and then released a guideline in August 1941 to promote the specialization in parts production (one plant, one product). However , it is not clear if these measures had any effects on compatibility. See Hirofumi Ueda, *Senjiki nihon no shitauke kogyo* [*Subcontracting Industries in Wartime Japan*] (Tokyo, 2004), 288.

[59] Takahiro Fujimoto, "A Note on the Origin of the 'Black Box Parts' Practice in the Japanese Motor Vehicle Industry," in *Fordism Transformed: The Development of Production Methods in the Automobile Industry*, ed. Haruhito Shiomi and Kazuo Wada (New York, 1995), 194. Kazuo Wada, "The Emergence of the 'Flow Production' Method in Japan," in *Fordism Transformed: The Development of Production Methods in the Automobile Industry*, ed. Haruhito Shiomi and Kazuo Wada (New York, 1995), 13-17.

[60] Michael Cusumano, *The Japanese Automobile Industry: The Technology and Management at Nissan and Toyota* (Cambridge, Mass., 1985), 120.

[61] Wada, "The Emergence of the 'Flow Production' Method in Japan," 25.

including the aircraft industry, also served as an important resource for the new parts suppliers during the postwar period.[62]

During the first years after the end of the war, the carmakers found it difficult to restart car production. It had de facto collapsed during the final phase of the war, because both its own capacity and that of its suppliers were mobilized for aircraft production. Even Toyota had to build its supplier network all over again under various restrictions.[63] Under insufficient and unstable demand for motor vehicles, the overall outsourcing situation in 1949 was, according to an official report, remarkably similar to that in the first half of the 1930s, with a trend to the arm's length transactions.[64] There were still insufficient conditions to support a close and stable relationship.

The recovery of the Japanese economy began in 1950 with the Korean War. An important policy during this period was the Keiretsu Diagnosis (*Keiretsu Shindan*), carried out by the prefecture. It was aimed at improving the management of both assembly plants and suppliers and the relationship between them through detailed analyses and evaluations as well as concrete proposals. Toyota underwent it during 1952 and 1953.[65] Prior to this, Toyota had no mechanism for providing suppliers with advice and technical guidance. So it was important for Toyota to learn from this diagnosis how to examine and evaluate the suppliers processes. After the diagnosis, Toyota set up the committee for quality control in October 1953 and began to actively examine and control the suppliers' production process, using the suppliers' cooperative association (*Kyohokai*).

Production at Toyota increased rapidly in the second half of the 1950s. The number of motor vehicles produced (cars, trucks, and buses) increased 700% from 22,786 in 1955 to 154,770 in 1960. It is noteworthy that the number of direct suppliers did not increase at the same pace during this period: only 31 firms were added to the first-tier suppliers throughout the 1950s.[66] Thus, Toyota coped with the rapid increase of production volume mainly by increasing orders to existing suppliers.

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[62] Hashimoto, *Nihon kigyo shisutemu no sengoshi,* 214.

[63] Ueda, "The Subcontracting System and Business Groups: The Case of the Japanese Automotive Industry," compared the direct suppliers of Toyota in 1944 and 1958 and found that only a quarter of the suppliers in the wartime maintained the relationship beyond the war (221, Table 9.2). This result suggests that most suppliers at the end of the wartime had temporary relations.

[64] Hashimoto, *Nihon kigyo shisutemu no sengoshi,* 214.

[65] Compare Wada "Jidosha Sangyo ni okeru Kaisoteki Kigyokan Kankei no Keisei–Toyota Jidosha no Jirei," and Ueda, "The Subcontracting System and Business Groups: The Case of the Japanese Automotive Industry," for details.

[66] Hirofumi Ueda, "Kodo seichoki shoki no jidosha sangyo to sapuraiya shisutemu (the Automobile Industry and the Supplier System in the Early High-Growth Period)," *Kikan Keizai Kenkyu* (Osaka City University) 24-2 (2001): 9.

Toyota preferred restricting the number of direct suppliers to maintain intensive control. Indeed, the direct suppliers increased their size remarkably during the same period. They needed huge investments to respond to rapidly increasing orders, which they obtained through special loans from government banks and public subsidies from the prefecture.[67]

From 1958 to 1960, Toyota experienced a series of technical difficulties that confronted the company with the serious need to further improve product quality.[68] Toyota coped with these troubles by intensifying their advice and guidance to the suppliers on improving their quality levels.[69] As a result, the Kanban system could be applied in 1963 to selected suppliers. After 1964, by enlarging the target of the Kanban system, Toyota actively encouraged suppliers to take full responsibility for quality control of delivered parts. In the second half of the 1960s, Toyota further trained the first-tier suppliers in purchasing control, entrusting them with supporting and instructing the second-tier suppliers.

According to Fujimoto, the "approved drawing system" or the supplier-design of parts prevailed at Nissan during the late 1960s, while the earliest evidence of this practice at Toyota goes back to 1949 when Nippondenso was separated from Toyota and had a considerable number of engineers. Thus we can regard the 1960s, the beginning of motorization in Japan, as the period during which "the Japanese supplier system" was gradually formed.[70]

To sum up the development of the supplier relationship in Japan, we find some similarities to the German experience. First, both in Germany and Japan, the supplier relationship was dominated by arm's length transactions during the prewar period and by intensive cooperation in the postwar period. Second, in both cases, the wartime experience, specifically in aircraft production, had some influence on postwar development. Third, new conditions during the postwar period, especially the rapid increase of production volume under restricted resources and with insufficient quality by suppliers, had a direct impact on the formation of stable and cooperative relationships.

There are, however, remarkable differences in the initial conditions between Germany and Japan. The automotive parts suppliers were already largely established during the prewar period in Germany, while they were underdeveloped in Japan. This difference may be reflected in the fact that Japanese carmakers' control of suppliers seems to be tighter

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[67] Ibid., 31.

[68] Wada, "Jidosha Sangyo ni okeru Kaisoteki Kigyokan Kankei no Keisei–Toyota Jidosha no Jirei," 13-14.

[69] The following description is based on Wada, "Jidosha Sangyo ni okeru Kaisoteki Kigyokan Kankei no Keisei–Toyota Jidosha no Jirei," 15-21, unless otherwise noted.

[70] Fujimoto, "A Note on the Origin of the 'Black Box Parts' Practice in the Japanese Motor Vehicle Industry," 192-196.

and more intensive because the problem of the suppliers' poor technology was more serious in Japan. Moreover, given the stage in the life cycle of the automotive industry, more time was needed from the end of the war to the beginning of motorization in Japan. In addition, we saw that the suppliers in wartime and in the 1950s were for the most part different firms. These factors support the argument that the discontinuity between wartime experience and the postwar system is larger in Japan, with the exception of the aircraft industry influence.

Conclusion

The business relationship of Daimler-Benz with its suppliers was transformed from an arm's length relationship with concentrated single-sourcing during the prewar period into a cooperative and stable relationship with double-sourcing during the postwar period. We assume that a similar trend applies to other German carmakers, although we have little direct evidence, due to the lack of sources. Similar trends are confirmed by postwar documents of parts suppliers, and it is hard to imagine that only Daimler-Benz would maintain a unique relationship with the suppliers when most major suppliers have trade relationships with almost all the carmakers.

An important turning point in the relationship can be found in the economic regulation during wartime. Under the severe pressures of this economic regulation and military production, Daimler-Benz provided the suppliers with continuous support and instruction and introduced cooperative product design with selected suppliers. There are reasons to believe that these wartime experiences influenced postwar development.

Indeed, we observe a noteworthy continuity with respect to leading personnel, products, production technology, and producers. First, some individuals in charge of outsourcing, production management, or economic regulation during wartime, remained in their positions until the 1950s.[71] Second, the last prewar car model 170V, the production of which was stopped in 1942, was the first and foremost model produced during the early postwar years. Third, technological conditions for mass production (the introduction of the conveyer system and the standardization of parts

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[71] The following were top managers bridging the prewar and wartime experiences and postwar development: President Wilhelm Haspel, former director of the Sindelfingen plant and the successor of President Kissel after his death in July 1942 until Jan. 1952; Oberbaurat Fritz Schmidt, the chairman of the standardization meetings in 1939, board member 1950-1958; Director Karl C. Müller, the president of the aircraft engine subsidy and the leader of the Aircraft Engine Ring from 1941, board member 1936-1955, and Director Fritz Nallinger who developed aircraft engines and agreed on the cooperative design with the selected suppliers, board member 1940-1965. Except for Fritz Schmidt, who was appointed as a board member in 1950, all of them belonged to the board of directors from the wartime to the 1950s (except for the 2 years' suspension 1945-1947).

and components) had already been achieved before the war. Fourth, most of the major suppliers in the prewar period remained suppliers, except for those remaining in the lost territory and East Germany.

Wellhöner argued that the full development of Fordism in Germany began at postwar Volkswagen.[72] The case of Daimler-Benz considered here, however, suggests that a prototype of the supplier system during a period of high economic growth is found in the wartime supplier relationship. We cannot deny the influence of the occupation policy during the early postwar years, such as the regulation of material sourcing and the unseating of top managers, but we do not believe that it had such a substantial impact as to bring the wartime experiences to naught.

However, other more direct reasons for these postwar changes lie in the new economic environment and experiences during the postwar period: especially the serious shortage of production materials as well as suppliers' delivery and quality problems, combined with a drastic increase in the demand for cars. Carmakers had to secure sufficient parts supplies and required the suppliers to keep a large production capacity with enormous capital investment over a longer term, which necessarily led to a stable business relationship with mutual commitment and technological cooperation. Then wartime experiences may have supported the formation of the new business relationship.

By comparing this German evidence with the Japanese, we can confirm some similarities and some differences. In both countries, the basic nature of the supplier relationship has changed from an arm's-length transaction during the prewar period to a stable relationship with intensive cooperation during the postwar period, while wartime experience seems to have had some influence on postwar development. However, the formation of a stable and cooperative relationship in Japan was more directly influenced by new conditions in the postwar period, especially at the beginning of motorization.

The evolution of the supplier network in both countries was dependent on the initial conditions of the automotive industry, and at what stage of its development it experienced wartime regulation, the postwar restart, and motorization. The differences in these factors explain both the differences between the current supplier relationships in Germany and Japan, and the greater discontinuity between wartime experience and the postwar system in Japan.

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[72] Wellhöner, *Weltmarkt—"Wirtschaftswunder"—Westdeutscher Fordismus.*