

# **Industrial Investment in Nazi Germany: The Forgotten Wartime Boom\***

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March 2006

## **Abstract**

To date we lack reliable data on the level of industrial investment in the Third Reich. In addition our overall knowledge of the quantitative significance of the war-related branches – autarky and armaments industries – is extremely patchy. And yet, a precise knowledge of these figures is clearly crucial if we are to arrive at a proper characterization of the political economy of the Third Reich. Investment strategies with their long-run implications for industrial output are particularly revealing as to the debate about a Blitzkrieg strategy supposedly pursued by Hitler's Germany early in the war. Furthermore, investment data may play a crucial part in demystifying Albert Speer's so-called armaments miracle, about which it is commonly claimed that it depended on intensive rather than extensive growth. This paper, based on largely unknown sources, attempts to fill this gap, providing figure for industrial investment for the entire period between 1936 and 1944. It will be shown that actual investment was substantially larger after 1938 than has hitherto been recognized. The paper will also present detailed estimates for investment in armaments and autarky industries for the period 1934-1943. These show that during the period 1940-1942 Germany experienced a spectacular investment boom, primarily directed towards widening the industrial base for war. This clearly should have substantial implications for the historiography, since it calls into question both the Blitzkrieg narrative and the conventional view of the armaments miracle.

\* This paper was written while the author was visiting the Economic Growth Center at Yale University between August 2005 and April 2006. I am grateful to the Economic Growth Center for financial support. I thank Christoph Buchheim and Timothy Guinnane for many helpful comments.

I. One of the most important questions regarding the political economy of the Third Reich is still a subject of controversy: how was at the German economy the end of the 1930s prepared to wage a war and how fast did it mobilize at the beginnings of the 1940s. Many scholars claim that a true mobilization did not occur until the end of 1941, allegedly because the Nazi regime intended to achieve its expansionistic aims by fighting short wars (*Blitzkriege*) with a comparatively low number of soldiers and arms. Not until December 1941 when the Red Army stopped the German *Wehrmacht* near Moscow and the United States entered into World War II would this strategy have been changed.<sup>1</sup> Now confronted with the prospect of a long-lasting war against the United States and Soviet Russia, the German military planners acknowledged that they had to increase their armament production considerably. Therefore some scholars characterize the German economy during the first two years of the war a "peace-like war economy".<sup>2</sup>

This interpretation was first expressed by the Final Report of the United States Strategic Bombing Survey (USSBS) published in October 1945: "The Germans did not plan for a long war, nor were they prepared for it. Hitler's strategy contemplated a series of separate thrusts and quick victories (...)"<sup>3</sup> Yet, this interpretation is based not on direct but only on indirect evidence. There is no single document that reveals that the Nazis would have been planned the war as a *Blitzkrieg*.<sup>4</sup> The indirect evidence relies on the following observations: First, according to the index provided by the German armament ministry munitions production remained static in 1940 and 1941. Second it is claimed that armament capacities increased only slowly.<sup>5</sup> Third, production of consumer goods decreased only slightly in this period.<sup>6</sup> Richard Overy raised some objections to this interpretation, noting that a

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<sup>1</sup> Barkai, *Nazi Economics*, p. 234-7.

<sup>2</sup> Wagenführ, *Industrie*, p. 25.

<sup>3</sup> United States Strategic Bombing Survey (ed.), *Effects*, p. 6. See also Klein, *Economic Preparations*; Milward, *Kriegswirtschaft*.

<sup>4</sup> See Overy, 'Hitler's War'.

<sup>5</sup> United States Strategic Bombing Survey (ed.), *Effects*, p. 7; Janssen, *Ministerium Speer*, p. 67; Müller, 'Mobilisierung', p. 353.

<sup>6</sup> United States Strategic Bombing Survey (ed.), *Effects*, p. 130-1.

substantial share of consumer goods were used by the *Wehrmacht* and that the per-capita-consumption of private households dropped after the war had started.<sup>7</sup> In addition, Overy as well as Rolf-Dieter Müller claim that the static armament production must be explained mostly by inefficiencies caused by the polycratic structure of the Nazi regime.<sup>8</sup> Yet, recently J. Adam Tooze questioned the latter view, pointing on serious problems of the data used so far, which underestimated the real output of the German war economy during the first years of the war.<sup>9</sup> His results suggest that not only the "*Blitzkrieg*-hypothesis" but also the "inefficiency-hypothesis" may be misleading.<sup>10</sup>

May be the most compelling argument, however, of the the supporters of the "*Blitzkrieg*-hypothesis" regards the industrial investment structure in the last years before the beginning of the war. For, the share of war-related investment (armament and autarky industries) on total industrial investment may be an especial good indicator for revealing the intentions of the Nazi regime, given that normally investments are planned at least one year beforehand. Burton H. Klein, one of the USSBS's economists, claimed, based on the investment figures published by the *Statistisches Reichsamt* (German Statistical Office): "Inspection of Germany's prewar pattern of investment shows that there was no pronounced concentration of its investment in those activities associated with economic preparations of war."<sup>11</sup>

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<sup>7</sup> Overy, *War and Economy*, p. 278, 288-90.

<sup>8</sup> Overy, 'Hitler's War'; Overy, *War and Economy*; Müller, 'Mobilisierung '. To an overview about this discussion, see Kershaw, *Nazi Dictatorship*, pp. 53-4; Tooze, 'No Room ', pp. 439-41.

<sup>9</sup> Tooze, 'No Room '.

<sup>10</sup> Other scholars have shown that a further assumption of the "inefficiency-hypothesis" supporters cannot be held: that before 1942 only cost-plus contracts were concluded between state and munitions producers, which did not induce incentives to increase efficiency. Scherner, 'Ohne Rücksicht ', pp. 186-7; Budraß/Scherner/Streb, 'Demystifying '; Scherner/Streb, 'Ende eines Mythos'. About this claim, see for instance Barkai, *Nazi Economics*, p. 237; Overy, 'Hitler's War', p. 286.

<sup>11</sup> Klein, *Economic Preparations*, p. 15.

However, Klein's results contradict the findings of many studies of German business history, which show that from 1936/37 on German industry was increasingly militarized in terms of investments and production.<sup>12</sup> Yet, these studies examine only companies of war-related branches. Thus, they must not necessarily be representative of German industry as a whole. Klein's results also contradict the fact that armament expenditure's share in German GDP increased significantly in the last years before the war. Given this, some authors feel entitled to christen the German economy at the end of the 1930s a "war-like peace economy".<sup>13</sup> In particular, as will be shown in detail in this paper, Klein's data about industrial prewar investment are not reliable.<sup>14</sup> The same is true regarding an estimate of industrial investment during the war.

Detailed information about the amount and the structure of industrial investments may also contribute to the discussion about the causes of the "so-called armament miracle", i.e. the significant increase of the German armament production after Albert Speer had been appointed armament minister at the beginnings of 1942. According to the conventional wisdom, increased munitions production was mainly due to rationalization measures implemented by Speer.<sup>15</sup> In other words, not extensive but mainly intensive growth characterizes the performance of the German armament industry from the end of 1941 on.<sup>16</sup> A recent study based on airplane producers, however, questions this view, demonstrating that the capital stock of the companies which were involved in the production of the JU 88, which was the most manufactured combat airplane in Nazi Germany, increased significantly from 1942 on.<sup>17</sup> Was this only an exception or was the JU 88 production representative of the whole armament industry?

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<sup>12</sup> Hayes, *Industry*; Hayes, *Degussa*; Abelshausen, 'Germany'.

<sup>13</sup> Barkai, *Nazi Economics*, p. 217-9.

<sup>14</sup> About the amount of armament investments the literature provides only fragmentary information. See for instance United States Strategic Bombing Survey (ed.), *Effects*, p. 60.

<sup>15</sup> Abelshausen, 'Germany' pp. 122-76; Overly, *War and Economy*; pp. 356-63; Weyres-v. Levetzow, *Rüstungswirtschaft*, pp. 47-9.

<sup>16</sup> See also Speer himself, Speer, *Erinnerungen*, p. 232.

<sup>17</sup> Budraß/Scherner/Streb, 'Demystifying '.

Understanding the industrial investment level may make a contribution to another question, too: the effects of strategic bombing in Nazi Germany. This discussion was re-opened by publications of Jörg Friedrich. Friedrich argues, at least implicitly, that, given the allegedly relatively small damages on industrial plants, the bombing of the population, which had no military effects, was especially precarious from a moral point of view.<sup>18</sup> The well-known information regarding small damages on industrial plants is mainly based on observations by the USSBS and on a calculation of Rolf Kregel in the 1950s. According to this estimate the West German industrial capital stock in 1945 even exceeded that at the end of the 1930s.<sup>19</sup> This calculation based on the following consideration: War damages are the difference between the real postwar capital stock on the one hand and on the other hand the potential postwar capital stock resulting from the real prewar capital stock plus war investments minus normal capital consumption during the war. Obviously, real bombing damages must have been bigger, if investments would have exceeded the numbers used so far.

Finally, such data may contribute to a further debate: the long-term effects of Nazi economic policy.<sup>20</sup> Werner Abelshauser on the one hand argues this policy would have had modernizing effects on the German economy, which significantly contributed to the massive growth in West Germany during the 1950s. Christoph Buchheim on the other hand characterizes the German economic development during the Nazi period as "deformed growth", supposing huge investments in armament branches, which were useless under "normal" economic conditions such as in Germany after the war. Yet, how can we identify "useless investments" and estimate their share on total industrial investment?

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<sup>18</sup> Friedrich, *Der Brand*, pp. 296-7.

<sup>19</sup> Kregel, *Anlagevermögen*, pp. 14-20, 76-7, 96.

<sup>20</sup> About the beginning of this discussion, see Abelshauser, 'Kriegswirtschaft'; Buchheim, 'Wirtschaftsentwicklung'. See also Tooze, 'Punktueller Modernisierung'; Ritschl, 'Der späte Fluch'.

In sum, information regarding the amount and the structure of German industrial investment during the Nazi period can be considered a research desideratum. This article tries to provide this information by using sources widely neglected so far: files of the *Wirtschaftsgruppe Maschinenbau*, a semi public trade organization that brought together machinery manufacturers, of the state-owned *Deutschen Revisions- und Treuhand AG*, which audited armament companies, of the *Statistisches Reichsamt*, of the *Reichsfinanzministerium* (ministry of finance), of the *Reichsministerium für Rüstung und Kriegsproduktion* (armament ministry), and of the Four Year Plan agency. In section II it will be shown that investment data used so far is incorrect. In the following section industrial machinery investment will be estimated by using mainly unpublished data and by employing the commodity-flow-method. Based on this time series and on further statistical data we re-estimate industrial investment in the Nazi period, showing that the data used so far lead to a significant underestimation of industrial investments, especially from 1938 on and during the first three years of the war. Finally, new data regarding the investment structure are provided. It can be shown that the impact of autarky investments on total industrial investment during the war was overestimated so far. An estimate of armament investment according to which huge investments occurred in the first two years of the war questions the prevailing "*Blitzkrieg*-hypothesis". For, this estimate suggests that the Nazi regime created the preconditions for waging a big war by significantly enlarging the war-related industrial capacities to the disadvantage of the civilian branches. The huge armament investments in 1942 and in 1943 indicate that the so-called armament miracle under munitions minister Albert Speer may have been also caused by extensive growth. In addition, by using an indicator based on market signals it can be shown that at least one third of total investment has to be considered capital misallocation. Finally, given the investment boom during World War II effects of strategic bombing may have exceeded significantly those estimated so far.

**II.** The *Statistisches Reichsamt* has published data about the level and structure of German industrial investment until 1939.<sup>21</sup> However, total investment numbers are incorrect because a large share of

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<sup>21</sup> Statistisches Handbuch von Deutschland, p. 612.

armament industry's investments is not included. For, from 1934 on the armed forces financed munitions plants that were leased by private companies.<sup>22</sup> In addition, the armed forces leased capital goods to private industry – so called „*reichseigene Maschinen*“.<sup>23</sup> Due to methodic reasons, neither leasing plants nor leasing capital goods was included in the officially published investments numbers.<sup>24</sup> Furthermore, for concealing the German rearmament these numbers do also not contain the whole investment in the air force armaments industry.<sup>25</sup> Until 1939 about 1.6 billion RM was invested in air force armament plants, more than 630 million RM in army leasing plants (*Heereseigene Industriebetriebe* or *HIB*), and at least about 800 million in leasing machines – in sum an amount which corresponds to total industrial investment in 1937 according the numbers published by the *Statistisches Reichsamt*.<sup>26</sup>

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<sup>22</sup> Regarding army leasing plants, see Hopmann, *MONTAN*; regarding those of the air force, see Budraß, *Flugzeugindustrie*, p. 366-8; regarding those of the navy, see for example, Meyhoff, *Blohm & Voss*, pp. 153, 183-6; regarding leasing plants, Abelshäuser, 'Rüstungsschmiede', p. 343.

<sup>23</sup> Kluge, 'Reichseigene Maschinen', pp. 505-6; Weyres–v. Levetzow, *Rüstungswirtschaft*, p. 142\*.

<sup>24</sup> Industrial investment numbers published by the German Statistical Office included – as usual in industrial investment statistics – only private investments, i.e. investments of companies, which had the legal form of a private profit-orientated firm. See BArch 3102/2731, *Die volkswirtschaftlichen Investitionen 1924-1938*. See also for the case of the investment statistic of the US, Gordon, '\$45 Billion', p. 221. Investment figures of the German Statistical Office relied on surveys of companies' investments or on assets changes provided by the balance sheets. However, in the balance sheets of the army leasing plants' holding *Montan GmbH* leasing assets were not listed as "assets" but as "trust estate" because this holding was a non-profit-corporation (BArch R 2301/5500, balance sheet of *Montan GmbH*, 31.12.1935, p. 29; Hopmann, *MONTAN*, p. 30; BArch R 2301/5463, *Vertrag zwischen dem Deutschen Reich und der Verwertungsgesellschaft für Montanindustrie GmbH vom 27.2.1936*, § 5 (1).) And in the balance sheets of the leaseholders leasing assets were not mentioned (See for instance, Fischer, *WASAG*, pp. 106-8, 121.)

<sup>25</sup> BArch 3102/2731, *Die volkswirtschaftlichen Investitionen 1924-1938*; BArch R 3102/2701, p. 32-4. See also Fremdling/Stäglin, 'Industrieerhebung'.

<sup>26</sup> Regarding army leasing plants' investments, see Hopmann, *MONTAN*, p. 121 Tab. 14; regarding those of air force armament plants see BArch R 2/5551, *Übersicht über die Investierung und Finanzierung der Luftwaffenrüstungsindustrie*, p. 17. The investment amount of leasing machines relies on the following consideration: In 1944 their book value amounted to about 800 million RM (BArch R 3/183, p. 213). Yet, in contrast to the peacetime period, the state provided leasing machines only in a small extent during the war. Kluge, 'Reichseigene Maschinen', p. 506; Weyres–v. Levetzow, *Rüstungswirtschaft*, p.

For the war period, Dietrich Eichholtz estimated industrial investment.<sup>27</sup> This estimate bases on an estimate of investments in the former Central Germany (*Mitteldeutschland*; today: East Germany) by Helmut Kupky and on an estimate of investments in West Germany (*Westdeutschland*) by Rolf Kregel, both published by the German Institute of Economic Research (*Deutsches Institut für Wirtschaftsforschung* or *DIW*).<sup>28</sup> These estimates relied on the machinery investment numbers between 1938 and 1944 in constant prices published after the war by the former chief statistician of the Nazi armament ministry, Rolf Wagenführ.<sup>29</sup> Kupky and Kregel assumed that in different industrial branches the respective ratio between construction and machinery investments during the period considered was fixed due to technical reasons. Thus, they felt entitled to employ the respective prewar ratios provided by the Statistical Office for estimating industrial investment during the war. By using information about price changes Kupky and Kregel estimated total industrial investment (in current prices) during the war period. For calculating the investments in the respective German regions, the authors assumed a correlation between investment and the value added of these regions provided by Bruno Gleitze.<sup>30</sup> By using interpolation Eichholtz estimated investment for all of Germany based on the information given by Kregel, Kupky, and Wagenführ.<sup>31</sup>

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196. Therefore we assume that new leasing machines during the war (by value) corresponded to the depreciation (by value) during the war.

<sup>27</sup> Eichholtz, *Kriegswirtschaft*, p. 381

<sup>28</sup> Kregel, 'Brutto-Anlage-Investitionen der westdeutschen Industrie', pp. 168-184; Kupky, 'Brutto-Anlage-Investitionen der mitteldeutschen Industrie', pp. 391-407.

<sup>29</sup> Kregel, 'Brutto-Anlage-Investitionen der westdeutschen Industrie', p. 181; Wagenführ, *Industrie*, p. 160. About Wagenführ's career see Tooze, *Statistics*, pp. 262, 273-4, 284-5; Kehrl, *Krisenmanager*, pp. 267-9, 502. About the *Planungsamt* (Plan Office), in which Wagenführ's statistical department was incorporated, see Müller, 'Albert Speer', pp. 343-8.

<sup>30</sup> Kupky, 'Brutto-Anlage-Investitionen der mitteldeutschen Industrie', p. 392. Hereby, information about the value added of these regions are based on estimates provided by Bruno Gleitze. See Gleitze, *Ostdeutsche Wirtschaft*.

<sup>31</sup> Eichholtz, *Kriegswirtschaft*, p. 381



Yet, this estimate is problematic. First, it seems very questionable to assume during a rearmament period a constant ratio between construction and machinery investment, as we will discuss in section IV. Second, it is unclear what is included in Wagenführ's machinery investment numbers. Are they equivalent to machinery investments in a narrow definition or do they contain all equipment such as self-provided capital goods or trucks for example? Do they represent machinery investments of the whole economy or only of the industrial sector as assumed by Eichholtz/Krengel/Kupky? Are these numbers even correct? There are other data on machinery investment, as shown by table 1, that differ significantly from those provided by Wagenführ – first, one of the armament ministry regarding machinery investment in 1943 of the whole economy and the industrial sector only, and second a time series of the domestic machinery sales between 1938 and 1944 provided by the USSBS.<sup>32</sup> Even if some scholars have noticed these differences, they were not able to explain them.<sup>33</sup>

**Table 1: Machinery investment and sales in Germany 1938-44 (bn. RM)**

	USSBS <sup>a</sup>	Armament ministry <sup>b</sup>	Wagenführ <sup>c</sup>
1938	3.657		2.9
1939	4.236		3.5
1940	4.336		3.7
1941	4.762		4.1
1942	4.802		4.2
1943	n.a.	5.028 (3.895)	3.7
1944	4.069		2.6

a United States Strategic Bombing Survey (ed.), *Effects*, p. 227, Appendix table 29 (domestic machinery sales).

b BArch R 3/1960, *Gliederung der Maschineninvestitionen nach den Fertigungen des Gesamtaufwandplans, verbessertes Ergebnis*, 15.9.1944, p. 175; in parenthesis machinery investment of the industrial sector.

c Wagenführ, *Industrie*, p. 160 (machinery investment).

<sup>32</sup> Wagenführ abstained without comment from presenting these data despite of the fact that he knew them when he published his book. BArch R 3/1960, Wagenführ to Baudisch, 18.9.1944, p. 172.

<sup>33</sup> Weyres von Levetzow for instance was well aware about these differences. Weyres–v. Levetzow, *Rüstungswirtschaft*, pp. 115, 97\*. Gerhard Gehrig did not use Wagenführ's data, when estimating the German capital stock in 1938. Obviously, he considered them to low. Gehrig, 'Sachkapitalbestand', p. 18, Table 3, p. 46.

The original source of Wagenführ's data (table 1, column III) is an unpublished survey of the German war economy provided by the armament ministry in the summer of 1944 (*Bericht des Planungsamts vom 29. Juni 1944 (Bericht über die deutsche Wirtschaftslage 1943/44)*).<sup>34</sup> This document could be traced in the archives.<sup>35</sup> Based on archival files we can also reconstruct the calculation of the time series of machinery investment given by this document. In January 1944 the *Wirtschaftsgruppe Maschinenbau* replied to an inquiry of the armament ministry regarding the machinery industry sales between 1936 and 1943.<sup>36</sup> Based on this information machinery sales could be disaggregated into domestic and foreign sales. Domestic sales could be decomposed into armament goods, repairs of machinery, production of new machinery (*Neuproduktion*) etc.<sup>37</sup> In February 1944, Wagenführ requested from the *Wirtschaftsgruppe Maschinenbauindustrie* information about machinery investments. To do this the *Wirtschaftsgruppe* subtracted for each sub-branch from the domestic production of new machinery sold in Germany in 1942 the sales of products that were input but not capital goods (as for example ball bearing). The result was an investment number of 4,225 million

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<sup>34</sup> The number for 1944 relies on a postwar estimate of Wagenführ. About the method of this estimate Wagenführ did not provide any information.

<sup>35</sup> Institut für Zeitgeschichte (IFZ), PS 1946, *Bericht zur deutschen Wirtschaftslage 1943/44*, p. 184. There is no hint that these numbers are expressed in constant prices – in contrast to Wagenführ's claim. However, given that the machinery price index during this period was constant, this difference plays no role. About this document's history of origin and content, see Scherner, 'Bericht'.

<sup>36</sup> For 1936-42, see. BArch R 3/1917, *Schreiben der Wirtschaftsgruppe Maschinenbau an Dr. Stoffregen im Planungsamt vom 22.1.1944 inklusiver diverser Anlagen*, pp. 19-63; for 1943, see BArch R 13 II/193, note, 24.7.1944. Stoffregen was the chief of the subdepartment "Planing of iron and metal processing" (*Fachabteilung "Planungen auf dem Gebiete der Eisen- und Metallverarbeitung ohne Haushalts- und Wirtschaftswaren"*), which was subordinated to the department "Technical planing" (*Hauptabteilung IV "Fachliche Planung"*) headed by Hans Kehrl. Kehrl, *Krisenmanager*, p. 501. The reason of this inquiry was the survey about the German war economy mentioned above.

<sup>37</sup> BArch R 3/1788, *Die deutsche Industrie*, pp. 8-9.

RM.<sup>38</sup> Using the total input-capital goods ratio of 1942 Wagenführ's department estimated the machinery investment between 1938 and 1943.

This estimate, however, has some shortcomings: First, by summing up the investment numbers of the various sub-branches the official of the *Wirtschaftsgruppe* made an adding or writing mistake of 300 million RM. Instead of 4,525 million RM he calculated 4,225 million RM.<sup>39</sup> Second, the extrapolation method used by Wagenführ's department implies that (i) the input-capital goods ratios of different sub-branches would be constant during 1936 and 1943 and (ii) that the shares of the different sub-branches sales of total machinery sales would be invariant compared with the relations of 1942. Regarding the performance of the input-capital goods ratios in the other years (except for 1942) we have no information. Yet, it can be shown that the shares of the different sub-branches sales on total machinery sales differed significantly in the years between 1936 and 1942.<sup>40</sup> Third, Wagenführ's numbers do not include machinery imports. As a consequence of these shortcomings Wagenführ 's method underestimated the machinery investment especially before 1942. In addition, and in contrast to the basic assumption of the Eichholtz/Krengel/Kupky estimates, machinery investment numbers contain machinery, which were normally invested outside of the industrial sector as farm machinery. Furthermore, they do not include all capital goods but only those manufactured by the sub-branches, which belonged to the *Wirtschaftsgruppe Maschinebau*. Trucks, for instance, were excluded.

Also the numbers published by the USSBS, which in contrast to Wagenführ 's data include machinery imports, have considerable shortcomings. They exclude two sub-branches of the *Wirtschaftsgruppe Maschinebau* – the locomotive branch and the sub-branch that manufactured gears and rolling bearings. The omission of the latter branch can probably be explained by the fact that the USSBS

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<sup>38</sup> Barch R 13 III/191, note about a meeting with Dr. Fey, 15.2.1944. Dr. Fey was a member of the department "Planing statistics" (*Hauptabteilung V Planstatistik*) headed by Wagenführ. His job included among others the preparation of investment statistics. Kehrl, *Krisenmanager*, p. 502.

<sup>39</sup> This is the result of a re-calculation by the author.

<sup>40</sup> See section III, table 2, 3, 4.

considered these goods as typical inputs. However, the USSBS considered all other branches' sales as capital goods – contrary to the detailed information provided by the *Wirtschaftsgruppe Maschinebau*.

In sum, neither the Wagenführ nor the USSBS numbers represent adequate estimates of the capital goods invested in Germany according to the narrow definition of the *Wirtschaftsgruppe Maschinebau*. What about the investment data for 1943 provided by the armament ministry in 1944?<sup>41</sup> In contrast to the investment estimates of the *Statistisches Reichsamt* before the war, which relied on surveys of the industrial companies, the armament ministry's estimate was based on the so-called commodity-flow-method.<sup>42</sup>

Yet, also this estimate is not useful: The basis of this estimate was an assessment of the domestic new machinery sales in 1943 of those branches, which belonged to the *Wirtschaftsgruppe Maschinenbau*. This assessment (6,025 billion RM) overestimated the real value by far (5,343 million RM).<sup>43</sup> These shortcomings were probably the reasons that Wagenführ refused to use this estimate in his book. However, the method used by the armament ministry for decomposing this estimate provides us with useful information for estimating autarky and armament investments, which will be done in a further section.<sup>44</sup> The result of this section, however, is that the well known data provide neither reliable

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<sup>41</sup> This estimate was associated with the attempt to design a so-called *Gesamtaufwandplan* (Total Plan), which should be an instrument for a more efficient planning of the German war economy. About this instrument see Tooze, *Statistics*, pp. 274-81; BArch R 3/464.

<sup>42</sup> Generally about this method, see Gehrig, 'Sachkapitalbestand', p. 14.

<sup>43</sup> For the number used for the investment estimate of the armament ministry, see BArch R 13 III/192, note, 3.8.1944; for the real value, see table 2.

<sup>44</sup> For decomposing the estimated machinery sales, the armament ministry used different information. Machine tools and woodworking machinery sales were estimated according to the iron allocation. This information was also used to identify the purchaser branches of these machineries, which were characterized as so-called *vermerkscheinpflichtige Maschinen* (machineries with preferential iron allocation). BArch R 13 III/192, note, 31.7.1944, *Aufgliederung des Inlandsumsatzes 1943 in zulassungspflichtigen Maschinenarten nach Abnehmergruppen geschätzt*; BArch R 3/1960, *Gliederung der Maschineninvestitionen nach den Fertigungen des Gesamtaufwandplans, verbessertes Ergebnis*, 15.9.1944, pp. 173-4. Sales of so called *zugelassene Maschinen* were estimated on the basis of their sales orders in 1943. For manufacturing *zugelassene*

machinery investment numbers during the war period nor correct estimates of total industrial investment during the Nazi period.

**III.** We will start the re-estimate of industrial machinery investments' by using the data about mechanical engineering sales between 1936 and 1942, which the *Wirtschaftsgruppe Maschinenbauindustrie*, as mentioned above, communicated to the armament ministry at the beginning of 1944. The sales numbers are decomposed mainly into four categories, as shown by table 2: first, the domestic sold newly produced machinery, second the munitions production, third the exported newly produced machinery, and fourth a category, which includes revenues of repairs etc. The domestic sold newly produced machinery as well as the exported newly produced machinery are disaggregated in sales of the 36 sub-branches that were included in the organization of the *Wirtschaftsgruppe Maschinenbauindustrie*, as shown in Appendix I, table 1. Numbers for the years 1928, 1943 and 1944 rely on other sources or are estimated.<sup>45</sup>

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*Maschinen* producers required a special permission. BArch R 13 III/192, note, 31.7.1944, *Aufgliederung des Inlandsumsatzes 1943 in zulassungspflichtigen Maschinenarten nach Abnehmergruppen geschätzt*; BArch R 13 III/193. Estimated sales of these machines were decomposed in different machinery sub-branches and in different purchasers according to the real sales in the period between July 1943 and February 1944, which were collected by a special survey. BArch R 13 III/192, note, 3.8.1944. The difference between those two machinery categories and total machinery sales were so called *zulassungs- und vermerkscheinfreie Maschinen*. The latter included especially machineries, which were inputs (as valves and fittings; gears and rolling bearings) or capital goods of branches outside of the industrial sector (as farm machinery; locomotives; office machinery; fire fighting apparatus; railroad safety equipment). BArch R 13 III/192, note, 1.8.1944, *Aufgliederung des Inlandsumsatzes 1943 in zulassungs- und vermerkscheinfreien Maschinenarten nach Fachgruppen geschätzt*. The sources do not provide information in which way this amount was decomposed in different machinery sub-branches and in different purchasers. However, we know that the armament ministry tried to eliminate input goods when estimating total investment. BArch R 3/1960, *Gliederung der Maschineninvestitionen nach den Fertigungen des Gesamtaufwandplans, verbessertes Ergebnis*, 15.9.1944, pp. 173-4.

<sup>45</sup> See Appendix I.

**Table 2: Sales of the German mechanical engineering sector 1928, 1936-44 (m. RM)**

	Domestic sales			Export of newly produced machinery	Total sales
	newly produced machinery	munitions	others <sup>e</sup>		
<b>1928<sup>a</sup></b>	<b>2,504</b>	<b>n.a.</b>	<b>n.a.</b>	<b>1,100</b>	<b>3,726<sup>f</sup></b>
1936 <sup>b</sup>	2,630	252 <sup>c</sup>	258	660	3,800
1937	3,300	n.a.	n.a.	880	4,500 <sup>g</sup>
1938	4,211	541	199	856	5,807
1939	4,990	700	329	731	6,650
1940	5,305	1,537	337	525	7,694
1941	5,912	2,120	451	597	9,080
1942	5,996	2,500	405	560	9,431
1943 <sup>d</sup>	5,343	2,602	n.a.	719	n.a. <sup>h</sup>
1944	4,888	3,264	n.a.	260	n.a. <sup>h</sup>

- a BArch R 13 III/193, *Umsatz im Maschinenbau (Neufabrikation) mengen- und wertmaessig in den Jahren 1928 und 1938*, 8.7.1941; BArch R 13 III/193, *Vorlaufige Ergebnisse ueber die Neufabrikation der deutschen Maschinenindustrie im Jahre 1937*, 24.3.1938.
- b For 1936-1942, see BArch R 3/1917, *Wirtschaftsgruppe Maschinenbau* to Dr. Stoffregen, 22.1.1944, pp. 19-63 (data refer to the current borders of the Reich).
- c BArch R 3102/3541, production survey of the mechanical engineering sector 1936.
- d For the munitions production in 1943 and in 1944, see United States Strategic Bombing Survey (ed.), *Effects*, Appendix Table 19, p. 219. For domestic and foreign sales of newly produced machinery in 1943 and in 1944 see Appendix I. All numbers are rounded.
- e Repairs; commission processing; renting etc.
- f In this year domestic sales without newly produced machinery amounted to 122 m. RM.
- g In this year domestic sales without newly produced machinery amounted to 400 m. RM.
- h Total production in 1943 and 1944 may not be significantly lower than in 1941, given that according to USSBS estimates machine tools repairs increased significantly in these years due to allied bombing. See United States Strategic Bombing Survey (ed.), *Effects*, pp. 44-5, 47-8.

In the following, based on these data and by using the commodity-flow-method, we re-estimate industrial machinery investments. In other words, we infer from potential purchasers of the goods produced by the different sub-branches on the investments in the different sectors of the economy. To do this, we have first to add the imports to the domestic sold newly produced machinery. In a second step we have to subtract from this amount the inputs and those goods that were typically invested outside of the industrial sector.

Information about machinery imports and their crude decomposition according to the mechanical engineering sector's sub-branches is published by various statistical sources. Numbers for the years

1942 and 1944, for which no information is available, could be estimated.<sup>46</sup> For estimating the input goods amount in the respective years, in a first step we multiply the input goods-sales ratios of different sub-branches (as calculated by the *Wirtschaftsgruppe Maschinenbau* for 1942 and shown in table 3) by the domestic sub-branches sales (documented in appendix I, table 1). In a second step we add those machinery imports, which can be identified as input goods.<sup>47</sup> The result of these procedures is the machinery investment of the German economy between 1936 and 1944.

**Table 3: Share of input goods on total sales of different mechanical engineering sub-branches in 1942<sup>a</sup>**

Sub-branches	Share of input goods on total sales (%)
washing machines	55 <sup>b</sup>
combustion engine	100
air compressors	12
pumps	52
cranes, derricks and elevators	36
valves and fittings	64
gears and roller bearings	82
fire fighting apparatus	51

a BArch R 13 III/191, note about a conversation with Dr. Fey, 15.2.1944.

b This was due to spare parts.

To estimate industrial machinery investment we have to subtract those investment goods that were normally purchased by branches outside of the industrial sector. To identify these branches we use general conclusions as well as information given by the industrial production statistic of 1936, which in a detailed way decomposed the sales of the respective sub-branches in different products.<sup>48</sup> Based on this information we can conclude that the following sub-branches produced capital goods predominantly invested outside of the industrial sector: farm machinery; locomotives; washing machines; fire fighting apparatus; railroad safety equipment. In the case of some other sub-branches, it

<sup>46</sup> See Appendix II.

<sup>47</sup> See Appendix II.

<sup>48</sup> See BArch R 3102/3541, *Produktionserhebung im Maschinenbau 1936*. Generally about this survey, see Tooze, 'Punktueller Modernisierung'.

is not very clear who was the dominant purchaser (office machinery; steam turbines; sewing machines; steam engines and locomobiles; heavy and calculating scales; safes and vaults; printing presses; roller engraving plates; water turbines). Only the sales of the first three sub-branches were significant, especially the office machinery industry with a share of 4 % on total domestic new machinery production in 1939. However, there is information that the authorities were the primary purchasers of this branch's production during the war.<sup>49</sup> And in the case of the sewing machines we know that they were almost exclusively sold during the war not to private households but to the clothing industry.<sup>50</sup> Thus, we relate the former during the war to the service sector and the latter to the industrial sector. For the prewar period (1936 to 1939) we assume, by default of further information, that 50% of the sales of both sub-branches were invested by the industrial sector. In addition, to avoid an overestimate of industrial investment we take for granted that between 1936 and 1944 the products of all other unclear sub-branches listed above were invested outside of the industrial sector. In the case of all other sub-branches we can conclude that they sold their products almost exclusively to the industrial sector (as for example machine tools, textile machinery etc.). Based on these considerations we can estimate and decompose the consumption of newly produced mechanical engineering products in Germany between 1936 and 1944, as shown by table 4.

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<sup>49</sup> Müller, 'Mobilisierung', p. 446. The same is true regarding printing machines. Ibid.

<sup>50</sup> BArch R 3101/11269, *Fachgruppe Naehmaschinenindustrie to Reichspropagandaamt Essen*, 23.2.1944.



**Table 4: German consumption of newly produced mechanical engineering products 1936-1944<sup>a</sup> (m. RM)**

	1936	1937	1938	1939	1940	1941	1942	1943	1944
1) Total consumption	2,660	3,327	4,249	5,040	5,361	6,051	6,247	5,629	5,121
2) Input import	11	10	13	22	27	58	110	128	105
3) Domestic produced inputs	488	621	770	898	1,051	1,289	1,408	1,398	1,326
4) Total input consumption	499	631	783	920	1,078	1,347	1,518	1,526	1,431
5) Non-industrial capital goods import	7	5	8	9	9	25	66	86	70
6) Domestic produced non-industrial capital goods	587	692	850	1,096	1,106	1,150	1,153	1,308	856
7) Total non-industrial investment	594	697	858	1,105	1,115	1,175	1,219	1,395	926
8) Industrial capital goods import	12	12	17	19	20	56	75	71	58
9) Domestic produced industrial capital goods	1,555	1,987	2,591	2,996	3,148	3,473	3,435	2,637	2,706
10) Total industrial investment	1,567	1,999	2,608	3,015	3,168	3,529	3,510	2,708	2,764
11) Total investment	2,161	2,696	3,466	4,120	4,283	4,704	4,729	4,103	3,690
12) Wagenführ's investment numbers			2,900	3,500	3,700	4,100	4,200	3,700	2,600

a About the method, see text. Consumer goods are subsumed under non-industrial capital goods, because their amount may have been very small.

Table 4 suggests a spectacular machinery investment boom in the German economy during the first three years of the war. Which sectors of the German economy benefited from this machinery investment boom, and in which way did the investment structure change, especially compared with 1928? To answer these questions, we selected those sub-branches that do not produce input goods and whose products were almost exclusively invested by one of the following four categories: the agricultural sector; railways; "war-related" industrial branches, and "non-war-related" industrial branches (including consumer goods). About 50% of all sub-branches fulfill these conditions. In the period between 1936 and 1944 they had a share of domestically produced machinery investments of about 70%. Thus, this selection seems to be representative.<sup>51</sup>

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<sup>51</sup> We excluded imports because information given by statistical sources do not allow a detailed decomposition. However, total imports had only a small impact on industrial investment as shown by table 4.

**Table 5: Sectoral structure of machinery investments in Germany (1928; 1936-44)**

	Real per-capita investment of the selected branches (1928=100) <sup>a</sup>	War-related branches <sup>b</sup>		Non-war-related branches <sup>c</sup>		Railways <sup>d</sup>		Agriculture <sup>e</sup>	
		Real per-capita investments (1928=100)	Share (in %)	Real per-capita investments (1928=100)	Share (in %)	Real per-capita investments (1928=100)	Share (in %)	Real per-capita investments (1928=100)	Share (in %)
1928	100	100	42	100	33	100	7	100	18
1936	129	176	57	72	19	112	6	145	20
1937	162	223	58	91	18	111	5	173	19
1938	176	247	59	93	18	122	5	184	19
1939	181	241	56	96	18	197	8	186	18
1940	191	284	62	71	12	252	9	173	16
1941	211	323	64	66	11	320	10	171	15
1942	205	320	65	50	8	407	14	148	13
1943	181	245	58	28	5	595	23	142	14
1944	161	261	68	25	5	414	18	81	9

Source: See appendix 1.

a: Data about equipment prices provided by Kregel (Kregel, 'Brutto-Anlage-Investitionen der westdeutschen Industrie', p. 397) and data about German population published by Wagenführ (Wagenführ, *Industrie*, p. 135) are used.

b: Machine tools; expendable tools; woodworking machinery; heat treating ovens and blast furnaces; foundry equipment; smelter and rolling mill equipment; construction equipment and machinery; chemical stills.

c: Textile machinery; sewing machines; food processing machinery; shoe and leather machinery; printing machines.

d: Locomotives; railroad safety equipment.

e: Farm machinery.

Table 5, as an first indicator for German investment structure's performance during the Nazi period, suggests some preliminary results:

- 1) It is sometimes claimed that railways and the agricultural sector were discriminated during the Nazi period.<sup>52</sup> This is not true in real terms but only in relative terms of machinery investments – roughly spoken for agriculture during the war period and for railways during the prewar period.<sup>53</sup>
- 2) In addition, it seems that already in 1936, and not, as sometimes suggested by the literature, from 1937/38 on, the machinery investment structure was significantly changed in favor of the war-related branches and to the disadvantage of the non-war-related industries – in absolute as well as in relative terms, compared with 1928. However, it is remarkable that non-war-related industries' share remained static during the last three peacetime years; the absolute values even increased. This suggests that in spite of the huge investments in war-related branches desired by the state private industry had substantial investment alternatives.
- 3) Interestingly enough, during the first years of the war, before the German economy transformed into a true war economy, at least by some accounts, machinery investment structure changed significantly in favor of the war-related branches, calling into question the *Blitzkrieg*-hypothesis. In a further section we will try to decompose the investment performance of war related industries into that of the autarky branches and that of the armament industries.

**IV.** In a next step, however, we first try to estimate total industrial investment. To do this, we have to use two different methods – one for the prewar period and one for the war. For the prewar period we

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<sup>52</sup> For railways, see for example United States Strategic Bombing Survey (ed.), *Effects*, pp. 68, 72; for agriculture, Barkai, *Nazi Economics*, p. 293, table 6.

<sup>53</sup> However, even if real agricultural machinery investment numbers were high, compared with 1928, this does not mean that they were high enough, especially during the war, given the labour shortage in the German war economy on the one hand and on the other hand German agriculture's low degree of mechanization. See for this argument, Tooze, 'Punktuelle Modernisierung'.

add the investments of the air force munitions industries, of the army leasing plants, and of the leasing machines to the industrial investment numbers published by the *Statistisches Reichsamt*.<sup>54</sup> Yet, given that data about navy leasing plants are not available, this method leads to an underestimate of munitions branches' investment during the period considered. However, compared with investment of the air force plants and army leasing plants these investments omitted by our estimate may have been small.<sup>55</sup> Private industry's investments in army and navy munitions plants are also excluded, but not due to a lack of information. The reason is that we have no hint that the industrial investment numbers published by the *Statistisches Reichsamt* does not already include these investments. Yet, these numbers will be considered in a further section.

For the war period we are confronted with the problem that, except for 1943, we have data about neither construction investments nor about equipment investments besides machinery, such as self-provided capital goods or trucks for example. For 1943 Wagenführ's department provided a rough estimate for self-provided capital goods. They amounted to 2 billion RM and belonged almost exclusively to the chemical and fuel industry as well as to the mining branch.<sup>56</sup> For the same year, Wagenführ's department also provides data for industrial construction investments which amounted to 1.834 billion RM.<sup>57</sup> Given the data gaps regarding these two investment components for almost the whole war period we have to use other information for a reliable estimate of German industrial investment in this time.

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<sup>54</sup> Given that we have only information about total air force armament investments until 1936 (260 million RM) and until 1939 (1,597 million RM), this amount is allocated relatively to single years according to those of the army leasing plants for which detailed annual data is available. The same method is employed regarding leasing machines.

<sup>55</sup> The navy was by far the smallest branch of the *Wehrmacht*.

<sup>56</sup> BArch R 3/1960, Wagenführ to Baudisch, 18.9.1944, pp. 172-174.

<sup>57</sup> BArch R 3/1960, Wagenführ to Baudisch, 1.8.1944, pp. 164-166. This number relies on industrial constructions permitted by the authorities. Even if not all constructions permitted were realized, Wagenführ emphasized that the calculated amount would have been realistic. For, constructions permitted in 1942 but not realized were effected in 1943. Ibid.

The starting point is information given by the *Statistisches Reichsamt*. This agency decomposed the published industrial investments between 1935 and 1938 in construction and equipment numbers.<sup>58</sup> During this period the ratio between construction and equipment investment was constant. This suggests that we can also assume this ratio for 1939. Yet, the industrial investment figures published by the *Statistisches Reichsamt* do not include, as mentioned, a substantial share of armament investments. We cannot presume that the construction-equipment ratio of the armament investments corresponded to that calculated by the *Statistisches Reichsamt*. For, armament capacities normally required special construction investments, especially air attack protection.<sup>59</sup> However, there are sources that allow a rough estimate of armament industries' respective ratio.

**Table 6: Indicators for the relationship between construction and equipment investments in the armament industries**

	annual construction-equipment investment ratio of air force armament industries				construction-equipment assets ratio of army leasing plants <sup>c</sup>
	<i>Heinkel</i> (Oranienburg) <sup>a</sup>	<i>Junkers</i> (Dessau) <sup>b</sup>	<i>Heinkel</i> (Rostock) <sup>c</sup>	<i>Luftfahrtanlagen GmbH</i> <sup>d</sup>	
1936	n.a.	n.a.	197	n.a.	n.a.
1937	n.a.	n.a.	n.a.	n.a.	n.a.
1938	n.a.	n.a.	352	n.a.	108
1939	n.a.	n.a.	104	309	69
1940	90	49	181	109	71
1941	79	65	87	154	76
1942	94	40	n.a.	75	79
1943	n.a.	49	n.a.	n.a.	n.a.

a For 1940, BArch R 8135/7498, report 1940; for 1.1.1941-31.3.1941, BArch R 8135/7499, report 1.1.1941-31.3.1941; for 1941, BArch R 8135/7499, report 1941/42; for 1942, BArch R 8135/7500, report 1942/43. From 1941 on the reporting year started with the beginning of April.

b For 1938/39, 1939/40, BArch R 8135/2548, report 1939/40; for 1940/41, BArch R 8135/7558, report 1940/41; for 1941/2, 1942/43 BArch R 8135/7960, report 1942/43. Calendar years in the table include investments from the beginning of October in the previous year until the end of September of the calendar year.

c For 1936, BArch R 8135/1491, report 1936; for 1938 BArch R 8135/4137, report 1938; for 1939 BArch R 8135/4137, report 1939; for 1940 BArch R 8135/4138, report 1940; for 1941, BArch R 8135/4735, report 1.1.1941-31.3.1941. The year 1941 in the table includes only investments in the period 1.1.1941 to 31.3.1942.

<sup>58</sup> BArch R 3102/2701, *Die Gesamtinvestitionen aufgeteilt nach Aufwendungen für Gebäude, Maschinen, Werkzeuge und kurzlebige Wirtschaftsgüter* (1935-1938), p. 36.

<sup>59</sup> See e.g. BArch R 2301/5591, *Stellungnahme betr. Rentabilität der Montanbetriebe vom 7.3.1942*, p. 40; BArch R 2/5253, *Bericht der Deutschen Revisions- und Treuhand AG über die Wirtschaftliche Forschungsgesellschaft 1943*, p. 89; United States Strategic Bombing Survey (ed.), *Effects*, p. 149.

- d For 1939, BArch R 8135/3980, report 1939/40, Al. I; for 1940, BArch R 8135/3980, report 1940/41, Al. I; for 1941, BArch R 8135/3982, report 1941/42, Al. I; für 1942, BArch R 8135/3982, report 1942/43, Al. I.
- e For 1938, BArch R 2301/5550, *Anschaffungswerte und Ausnutzung der „Montan“-Betriebe im Geschäftsjahr 1937/38 (1.4.37-31.3.1938)*, pp. 41-2; for 1939-42, BArch R 2301/5503, report 1941/42, p. 170.

By evaluating audit reports of important air force munitions companies – *Junkers, Heinkel* as well as the holding company of all air force leasing plants, *Luftfahrtanlagen GmbH* – we can calculate a weighted average ratio between construction and equipment investments of about 100%. This sample seems to be somewhat representative because in 1940 and 1941 it contains investments of about 580 m. RM, which corresponds to approximately 22% of total air force armament industry investment in this period. In the case of all army leasing plants this ratio was on average only a little bit lower, as shown by table 6. Given these results, it seems clear that armaments industries' construction-equipment ratio was significantly higher than that of "normal" industry, which according to the data of the *Statistisches Reichsamt* mentioned above amounted to about 28%.

Thus, it seems acceptable to presume during the prewar period a construction-equipment ratio of the armament industry (excluded leasing machines) of about 100%. Based on this assumption we can calculate total construction and equipment investment of the whole German industry between 1936 and 1939 (Table 7, rows 10, 11). If we subtract from the equipment time series the machinery investments estimated in the previous section, a time series for equipment without machinery, i.e. self-provided equipment, trucks etc. results (Table 7, row 13).

**Table 7: Machinery, equipment, construction and total investments in the German industry 1936-9 (1943) in m. RM**

	1936	1937	1938	1939	1940	1941	1942	1943	1944
1) Construction investment (armament ministry) <sup>a</sup>								1,834	
2) Self-provided equipment (armament ministry) <sup>b</sup>								1,800	
3) Industrial investment ( <i>Statistisches Reichsamt</i> ) <sup>c</sup>	2,159	2,843	3,691	4,432					
4) Construction investment ( <i>Statistisches Reichsamt</i> ) <sup>d</sup>	458	616	814	977					
5) Equipment investment ( <i>Statistisches Reichsamt</i> ) <sup>d</sup>	1,701	2,227	2,877	3,455					
6) Estimated armament investments <sup>e</sup>	334	494	988	1,473					
7) Estimated industrial investment <sup>f</sup>	2,493	3,337	4,679	5,905					
8) Estimated armament industry construction investment <sup>g</sup>	135	182	381	556					
9) Estimated armament industry equipment investment <sup>g</sup>	199	312	607	917					
10) Estimated industrial construction investment <sup>h</sup>	593	798	1,195	1,533					
11) Estimated industrial equipment investment <sup>i</sup>	1,900	2,539	3,484	4,372					
12) Estimated industrial machinery investment <sup>j</sup>	1,567	1,999	2,608	3,015	3,168	3,529	3,510	2,708	2,764
13) Estimated industrial equipment investment without machinery <sup>k</sup>	333	540	876	1,357					

- a BArch R 3/1960, *Bauinvestitionen 1943, gegliedert nach den Fertigungen des Gesamtaufwandsplans der deutschen Volkswirtschaft Großdeutsches Reich ohne Protektorat*, 23.7.1944, p. 165.
- b BArch R 3/1960, Wagenführ to Baudisch, 18.9.1944, pp. 172-174. This document emphasizes that self-provided equipment belonged almost exclusively to the industrial sector. Therefore, we assume a share of 90%.
- c Statistisches Handbuch von Deutschland, p. 605.
- d BArch R 3102/2701, *Die Gesamtinvestitionen aufgeteilt nach Aufwendungen für Gebäude, Maschinen, Werkzeuge und kurzlebige Wirtschaftsgüter* (1935-1938), p. 36. The ratio of 1939 is extrapolated.
- e For army leasing plants, see Hopmann, *MONTAN*, p. 121 Tab. 14; for air force armament plants, see BArch R 2/5551, *Übersicht über die Investierung und Finanzierung der Luftwaffenrüstungsindustrie*, p. 17.
- f Row 7 results from adding rows 3 and 6.
- g We assumed according to table 6 that the construction equipment ratio of armament plants (excluding leasing machines) amounted to 100%.
- h Row 10 results from adding rows 4 and 8.
- i Row 11 results from adding rows 5 and 9.
- j See table 4, row 10. The numbers include the production of Austria (1938 and 1939) and that of the *Sudetenland* (1939). The respective numbers, however, were in these years negligible.
- k Row 13 results from row 11 minus row 12.



In the next step, based on these results, we can calculate the respective ratios in 1936-1939 between the different components of total industrial investment – machinery investment (**M**), equipment investment without machinery (**E**), and construction investment (**C**). When doing this, it can be shown that the **C/M** ratio as well as the **(C+E)/M**, the **C/(E+M)**, and **E/M** ratios increased significantly over time.

**Table 8: Ratios of total industrial investments' components 1936-9, 1943**

	C/M	E/M	(C+E)/M	C/(E+M)
1936	38	21	59	31
1937	40	27	67	31
1938	46	34	79	34
1939	51	45	96	35
1940				
1941				
1942				
1943	68	66	134	41
1944				

Source: Table 7.

For 1943 we can also determine the different ratios. However, in this year the **(C+E)/M** as well as **E/M** ratios represent a lower limit because self-provided equipment is only a subset of equipment investments without machinery (and consequently the **C/(E+M)** ratio an upper limit). Anyway, the ratios increased compared with 1939. This result seems to be plausible in spite of the huge increase. First, we have to remark that the ratios relying on nominal values are somewhat distorted in the period considered, especially between 1939 and 1943, given that construction prices grew significantly whereas equipment prices remained static. Second, the net value (in constant prices) of German fuels and chemical production as well as that of the metalworking branch, which includes the bulk of the armament industries, grew above average between 1939 and 1943.<sup>60</sup> In the former branch, self

<sup>60</sup> United States Strategic Bombing Survey (ed.), *Effects*, p. 27 table 5. About the reliability of these data provided by the USSBS, see Tooze, 'No Room for Miracles'. This estimate refers to the prewar borders of Germany. However, regarding the total industrial product, annexed territories' impact was insignificant. See Scherner, 'Bericht'.

provided equipment and in the latter, construction investments had typically an investment share, which exceeded that of the industry in average. And in both sectors companies normally operated at full capacity at the end of the 1930s. Thus, we can assume above-average investment in both sectors between 1939 and 1943. Regarding the armament industries, this conclusion is confirmed by another indicator: the armaments industry's share of total machinery investments, which increased considerably from 8% in 1939 to about 22% in 1943.<sup>61</sup> Thus it seems apt to assume that in the 1940s the  $(C+E)/M$ -ratio corresponded at least to the value of 1939, i.e. 96%. An alternative method is an interpolation between the 1939 and 1943 values, which may represent an upper limit on Germany's industrial investment. Both methods will be employed in the following (except for 1943).

## V.

Both re-estimates of total industrial investment in Nazi Germany show – almost exclusively – significantly higher numbers than those calculated by Eichholtz, especially from 1938 on. Even if also according to the re-estimates investment decreased considerably from 1943 on, it was still high in the final years of the war as be proven by a comparison of real per-capita-investment in these years with those of the last prewar years. Still in 1944 this ratio corresponded at least to that of 1937, which is considered as a boom year. Given the huge bombing damages from the beginning of 1944 on and the attempts to dislocate industrial plants, this result does not seem to be surprising.<sup>62</sup>

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<sup>61</sup> See Appendix III, Appendix table 3.

<sup>62</sup> The decrease of real per-capita investment between 1939 and 1940 – in contrast to the results of table 5 – can mainly be explained by the fact that in the latter population numbers used include Austria and *Sudetenland* from 1938 on whereas in table 9 not until 1940. The reason is based on the fact that in table 9 two different methods are used – one for the prewar time mainly relying on published numbers of Germany in the 1937 borders, and one war estimate relying on machinery investment of Greater Germany. In the case of the prewar border estimate, we therefore assume that significant armament investments were not effected in Austria and Sudetengebiet before 1940.

**Table 9: Re-estimates of industrial investment in Germany<sup>a</sup>**

	Eichholtz' estimate <sup>b</sup> in current prices (m. RM)	Re-estimates in current prices (m. RM)		real per-capita-investment in percent of per-capita-investment in 1928 <sup>c</sup>	
		(lower limit)	(upper limit)	(lower limit)	(upper limit)
<b>1928</b>	<b>2615</b>	<b>2615</b>		<b>100</b>	
1932	439	439		20	
1933	557	557		26	
1934	1,060	1,076		51	
1935	1,639	1,714		81	
1936	2,159	2,493		118	
1937	2,843	3,337		157	
1938	3,691	4,679 <sup>d</sup>		220 <sup>d</sup>	
1939	4,432	5,905 <sup>d</sup>		276 <sup>d</sup>	
1940	4,861	6,209	6,510	215	226
1941	5,254	6,917	7,587	237	259
1942	5,564	6,881	7,882	234	268
1943	4,906	6,344		208	
1944	3,505	5,417	6,730	180	220

a From 1940 on re-estimates include Austria, *Sudetengebiet*, and territories annexed from Poland.

b Eichholtz, *Kriegswirtschaft*, p. 381. Eichholtz claims that his estimate for the war period would refer to Germany in the prewar borders. However, given that he used the Wagenführ machinery data, which refer to Germany in the respective borders, this claim cannot be hold. Thus, we can compare our re-estimate with the figures provided by Eichholtz.

c From 1940 on numbers include the population of Austria, *Sudetengebiet*, and territories annexed from Poland. For the population, see Wagenführ, *Industrie*, p. 135; for construction and equipment price indices, see Kregel, 'Brutto-Anlage-Investitionen der westdeutschen Industrie', Übersicht 10, p. 184.

d These numbers – especially those regarding 1939 – are somewhat inflated because a part of the armament investments omitted by the *Statistisches Reichsamt* was invested in Austria and *Sudetengebiet*, both of which were annexed in 1938.

The fact that the re-estimated investment numbers significantly exceeded those assumed so far also suggests that the effects of allied bombing were bigger than calculated by Rolf Kregel for West Germany. Kregel's estimate relies on the capital stock of the West German industry before and after the war. The data used for the prewar value are the investment numbers published by the *Statistisches Reichsamt*. Kregel estimated the post war capital stock by using information about postwar investment and about the value added of industry under the condition of full employment in the 1950s. Taking into consideration the normal capital consumption and his war investment estimate, he

calculated that war damages corresponded to only 20% of the gross capital stock of 1942.<sup>63</sup> War damages were allocated to single years with different intensities, which seem to be correlated, even if Kregel does not provide exact information, to the intensity of bombing attacks.<sup>64</sup> Based on the results of table 9, we can infer that in this period investments exceeded Kregel's estimate by about 2.2-4.4 billion RM.<sup>65</sup> Thus, war damages measured in net values, i.e. in the time value of assets in 1944/45, must have exceeded the figures calculated by Kregel by about 20-53% – instead of 8.681 billion DM (in constant prices of 1950) about 10.4-13.3 billion DM!<sup>66</sup> Without war destruction, West German industry's net capital stock in 1945 would have exceeded the real one by about 27-35%, instead of "only" about 23% as calculated by Kregel.<sup>67</sup>

What was the share of autarky investments in total industrial investments? First of all we have to note that the well-known data about Four Year Plan investments between 1936 and 1942 given by Petzina are not used because they are incorrect due to a transcription error.<sup>68</sup> Therefore information about Four Year Plan investments given by the original source is employed. Based on these data Four Year Plan investments exceeded Petzina's numbers by a factor of 1.2 (Table 10, columns I, III). However, the

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<sup>63</sup> Kregel, *Anlagevermögen*, pp. 76, 94.

<sup>64</sup> About quantitative data regarding the allied bombing, see United States Strategic Bombing Survey (ed.), *Effects*.

<sup>65</sup> We assumed that the West German share on total investment in Nazi Germany between 1934 and 1939 matched that presumed by Kregel (about 60%, which matched also the West German population share on the population of Germany in the 1937 borders). During the war period we presume a share of about 50%. This share exceeds a little bit that one of West Germany's population on Greater Germany's population. Yet, the annexed territories were in average less industrialized than West Germany.

<sup>66</sup> Depreciations are calculated as suggested by Kregel, *Anlagevermögen*, pp. 70-1.

<sup>67</sup> Own calculation based on the information given by table 9; Kregel, 'Brutto-Anlage-Investitionen der westdeutschen Industrie', p. 170-71, Kregel, *Anlagevermögen*, pp. 96, 104.

<sup>68</sup> The Four Year Plan agency's investment numbers are based on steel allocation for the Four Year Plan plants. Using chemical industry's experience regarding the steel-investment ratio, the authorities estimated the amount invested. The numbers published by Petzina, however, are steel allocation numbers in 1.000 tons. Staatsarchiv Nuernberg, NI-8915, *Vierjahresplan, Chemischer Erzeugungsplan, Steigerung der Erzeugung, Reichsmarschall Goering, Beauftragter fuer den Vierjahresplan, Stand Januar 1943*, pp. 9-10.

revised data still include investments in explosive and powder plants, i.e. investment that must be subsumed to armament but not to autarky branches. Taking into consideration this (Table 10, column IV) it can be shown that the data used so far significantly overestimated the share of autarky investments of total industrial investment during the war (Table 10, column V). In addition, it seems that just before the implementation of the Four Year plan German industrial investment structure was considerably affected by autarky related capacity enlargements – for two reasons: First, autarky investments in 1936 cannot really be caused by the Four Year Plan, given that this plan was promulgated in the autumn of that year. Second, autarky investment numbers in 1936, as provided by table 10, refer only to the last six months of that year. Therefore this result – at least quantitatively – contradicts Petzina's statement that before the implementation of the Four Year plan only a weak version of autarky policy existed.<sup>69</sup> Yet, this result is not surprising given the fact that already the 1934 *Gesetz zur Übernahme von Garantien zum Ausbau der Rohstoffwirtschaft* (Law for the Assumption of Guarantees for Expansion of the Raw Material Economy), the legal basis for state's support of the autarky branches, explicitly emphasised to achieve the highest level of autarky possible.<sup>70</sup>

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<sup>69</sup> Petzina, *Autarkiepolitik*, pp. 24, 27, 48, 50.

<sup>70</sup> Scherner, 'Gesetz', p. 348. This justification was never published in contrast to the normal practice – probably for concealing the aims of the Nazi regime. *Ibid.*

**Table 10: The impact auf autarky and armament investments on industrial investments in the Third Reich; 1934-43**

	Petzina's numbers		Re-estimates						
	I: Four-Year- Plan investment (m. RM) <sup>a</sup>	II: I in percent of industrial investment <sup>b</sup>	III: Four-Year- Plan investment (m. RM) <sup>c</sup>	IV: autarky investment (m. RM) <sup>e</sup>	V: IV in percent of re- estimated industrial investment <sup>f</sup>	VI: armament investment (m. RM) <sup>g</sup>	VII: VI in percent of re-estimated industrial investment <sup>f</sup>	VIII: IV + VI in percent of re- estimated industrial investment <sup>f</sup>	IX: "free" real per-capita- investment <sup>f</sup> in percent of real per-capita- investment <sup>h</sup> in 1928
1934	na	na.	na.	199	18	57	5	23	
1935	na.	na.	na.	352	21	75	4	25	
1936	750	34	>906	>906	>36	373	15	>51	<58
1937	1,500	53,5	1,811	1,811	54	575	17	71	46
1938	1,950	52,7	2,358	2,180	47	1,128	24	71	64
1939	2,100	47,7	2,536	2,178	37	1,699	29	68	88
1940	2,490	58	3,007	2,254	35-36	2,406	37-39	72-75	54-63
1941	2,490	54	3,007	2,127	28-31	2,619	35-38	62-68	76-98
1942	1,970	40	2,379	1,925	24-28	2,498	32-36	56-64	84-118
1943	na.	na.	2,411 <sup>d</sup>	2,408	38	1,793	28	66	71

a Petzina, *Autarkiepolitik*, p. 183.

b Ibid. Industrial investment numbers used by Petzina are the sum of Kregel's estimate for West Germany and Kupky's estimate for Central Germany.

c Staatsarchiv Nuremberg, NI-8915, *Vierjahresplan, Chemischer Erzeugungsplan, Steigerung der Erzeugung, Reichsmarschall Goering, Beauftragter fuer den Vierjahresplan, Stand Januar 1943*, pp. 9-10. The number for 1936 refers only to the last six month of the year.

d See Appendix IV.

e Autarky investments in 1934 and 1935 are calculated on the basis of investments in metal ore mining (*Metallerzbergbau*), cellulose fibre industry (*Chemiefaserindustrie*), and fuel industry (*Kraftstoffindustrie*) given by the *Statistisches Reichsam*. These branches were considered autarky branches according to the Law for the Assumption of Guarantees for Expansion of the Raw Material Economy promulgated in 1934. Powder and explosives investment for 1937-42 are based on Hopmann's data and that for 1943 rely on Appendix IV. Numbers for 1936 are not available.

f For 1940-2 upper and lower limit total industrial investment estimates are employed.

g See Appendix V.

h See table 9.

What was armament industry's share of total industrial investment? An estimate shows that at least from 1936 on this ratio played an important role (Table 10, column VII).<sup>71</sup> In addition, this estimate contradicts the so-called "*Blitzkrieg*-hypothesis". For, it can be taken for granted that investments are planned at least one year beforehand. If so, we can conclude given the dramatically increasing armament investments between 1938 and 1941 that the Nazi planners reckoned that the existing capacities would have been too small for realizing their expansionistic aims. Especially the capacity enlargement during the *Blitzkrieg* period suggests that the Nazis prepared a long-standing war with bigger dimensions than those of the campaigns so far.

We can confirm the claim of the literature that from 1937 on the Nazi economic policy's impact on the investment structure was substantial by calculating the share of autarky and armament investments on total industrial investment (Table 10, column VIII).<sup>72</sup> However, that does not necessarily mean that investments of which the state was not interested were totally crowded out. This is shown by calculating an indicator for so-called "free" real investments per capita in the Nazi period as a percent of real per-capita-investments in 1928 (Table 10, column IX).<sup>73</sup> It is remarkable that this ratio increased during the last three peacetime years, which corresponds to the results of table 5 regarding non-war-related machinery investments. It is further remarkable that these numbers did not decrease dramatically during the war. This suggests that in fact at the end of the 1930s the German economy can be considered – in terms of investment structure – a "war-like peace economy".<sup>74</sup> However, this

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<sup>71</sup> For this estimate see Appendix V.

<sup>72</sup> See for instance Hayes, *Degussa*.

<sup>73</sup> However, given the high profits in this period, "free" investments must be considered small. About industrial profits see Spoerer, *Von Scheingewinnen*, p. 147. In addition, a big part of these investments were probably replacement investments. On the other hand, a part of autarky investments would have been probably realized even without the economic framework provided by the Nazi regime. For the case of the cellulosic fibre industry, for example, see Scherner, 'Chemiefaserindustrie'.

<sup>74</sup> These results are confirmed when examining chemical giant *IG Farben AG*'s share of real "free" investment, which in the average of 1937-1940 amounted to at least 60% of those in 1928. Based on Plumpe, investments in metals, fuel, cellulosic and synthetic fibres, synthetic rubber, as well as in explosives are considered investments desired by the state. Plumpe, *IG-Farbenindustrie-AG*, pp. 467, 596, 594.

indicator also shows that there were alternatives, albeit limited ones, for the industry to invest outside of the autarky and armament branches.<sup>75</sup>

Finally, the re-estimates allow us to draw conclusions regarding the share of capital misallocation on total industrial investment – at least from an *ex-ante* perspective. To do this we have to incorporate market signals in our analysis. For, generally companies were not forced to invest according to the wishes of the Nazi regime.<sup>76</sup> For inducing the investments desired the state offered a bundle of different contracts. These contracts differed in the way that amortization risk was shared between the state and private companies. Normally, companies chose a leasing contract, under which they run a state-owned plant, if they assumed that they could not use these plants in the long run, especially in the case of a normalization of the economic policy.<sup>77</sup> Given this, it is not surprising that private companies were normally not disposed to buy such leasing plants offered by the state during the war, even if the price was very low compared with the capital invested.<sup>78</sup> The same is true regarding leasing machines, which the armament ministry intended to sell entirely from spring 1943 on.<sup>79</sup> Only a small share of these machines was sold despite significant price reductions compared with the net book values.<sup>80</sup> In addition, due to the high risk associated with using armament plants for peacetime purposes, the state and the private industry concluded investment contracts in armament branches, with which the state

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<sup>75</sup> This is confirmed by a statement of Kehrl at the end of 1943, emphasizing the high industrial investments for peace-time purposes. Müller, 'Mobilisierung', pp.446-7.

<sup>76</sup> Scherner, 'Verhältnis'; Buchheim/Scherner, 'Role of Private Property'.

<sup>77</sup> The same consideration is true for leasing machines. For an example, see BArch R 3/1825, *Semperit Gummiwerke AG* to armament ministry, 23.12.1943, p. 243.

<sup>78</sup> Hopmann, *MONTAN*, pp. 131-4.

<sup>79</sup> BArch R 3/1825, *Erlaß betr. Fertigungseinrichtungen in Rüstungsbetrieben (Maschinen-Grundsätze) vom 28.3.1943*, pp. 251-255. BArch R 3/1825, Speer to High Army Command (*OKH*), 15.5.1944, pp. 211-2.

<sup>80</sup> BArch R 3/1825, *Erlaß betr. Fertigungseinrichtungen in Rüstungsbetrieben (Maschinen-Grundsätze) vom 28.3.1943*, p. 253. At the end of September 1943 the values of army leasing machines amounted to 743 m. RM. Until the end of March 1944 machine sales revenue amounted to only 12 m. RM. BArch R 3/183, p. 213. Also the US government effectuated only small sales revenues, when selling state owned armament plants to private companies after World War II. Gordon, '\$45 Billion'.



took the whole or almost the whole of the amortization risk.<sup>81</sup> In other words, private companies' contract choices suggest that they widely considered all these investments – at least a third of total investments during the whole Nazi period and a half during the war – misallocations.<sup>82</sup>

## **Conclusion**

- 1) It seems that industrial investments exceeded significantly – by 10-14 billion RM or 25-35% – the numbers assumed so far. The biggest part of this difference – about 60-80% – belongs to the war period. Thus, allied strategic bombing obviously had greater effects than estimated by Kregel.
- 2) The share of actual autarky investments especially during the war was considerably smaller than assumed by Petzina. This was first due to bigger total investments and second due to the fact that investments in powder and explosive plants had an increasing impact on Four Year plan investments. In addition, it seems that just before the implementation of the Four Year plan, autarky played a significant role regarding the German industrial investment structure.
- 3) The results regarding the investment structure as well as those regarding the amount of armament and autarky investments question the hypothesis that in this period the Nazi regime assumed to achieve his expansionistic aims only by fighting *Blitzkriege*. In addition, these results confirm the hypothesis that at least from 1937 on investment projects desired by the

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<sup>81</sup> In the case of private air force armament producers contracts were concluded which guaranteed invested capital's amortization. Later, the state provided lost subsidies. Budraß, *Flugzeugindustrie*, p. 364; BArch R 2 Anh./37, pp. 31-3. In addition, during the war companies could finance armament investments by means of public investment loans with a so called war risk clause (*Kriegsrisikoklausel*), according to which in the case of a drop of orders the capital goods financed by the loan passed in the property of the state as well as the company was freed to repay the loan. Kluge, 'Reichseigene Maschinen', p. 506; Weyres-v. Levetzow, *Rüstungswirtschaft*, pp. 193, 139\*.

<sup>82</sup> Also some autarky investments must be considered misallocations from the view point of a "normal" market economy. However, it seems that the share of misallocations on total autarky investments was significantly smaller than that in the armament industry because leasing contracts and similar contractual types were less important than in the case of the latter. For an example of leasing type contracts in the case of the mining of copper ores, see Scherner, 'Ohne Rücksicht'.

state increased considerably. Measured by the investment structure, it seems apt to characterize the German economy from this point of time on a "war-like peacetime economy". However, "free" investment, i.e. investment not desired by the state, was still possible, even if reduced compared with 1928. Therefore, we cannot say that companies did not have alternatives to autarky and armament investments. This leeway, in spite of huge misallocations, may have favored the rise of West Germany's economy in the 1950s.

## Appendix I

The numbers provided by the *Wirtschaftsgruppe Maschinenbauindustrie* for 1936-42 are completed for 1943-4 by information mainly published by the USSBS. The USSBS data – based on an study of the *Wirtschaftsgruppe Maschinenbauindustrie* in the summer 1945 – provide information about armament production and sales of newly produced machinery.<sup>83</sup> However in the USSBS table "Annual sales of capital goods, 1938-1944" information about the sub-branch that manufactured gears and rolling bearings is omitted, and the sub-branch that produced locomotives is included in "rolling stock" instead of "machinery".<sup>84</sup> A further difference to the data provided by the *Wirtschaftsgruppe Maschinenbauindustrie* in 1944 is that sales of machinery products are not decomposed in domestic sales and exports. However, in another table the USSBS published export numbers except for 1943.<sup>85</sup> The problem regarding the omitted gears and rolling bearings sales data is solved by using information published after the war by the *Statistisches Handbuch von Deutschland*, which provides us a number for 1944.<sup>86</sup> The number for 1943 is estimated by calculating the mean of the 1942 and 1944 values. The *Statistische Handbuch* also provides export data for 1943.<sup>87</sup> Unfortunately, for some sub-branches export data for 1943 as well as for 1944 (given by the USSBS) are aggregated. To resolve this, the export share of the respective sub-branch on total exports in 1942 is extrapolated.<sup>88</sup> Based on these considerations and data, we can estimate total sales of the mechanical engineering sector as well as the decomposition regarding newly produced machineries in the 36 sub-branches of the *Wirtschaftsgruppe Maschinenbauindustrie*.<sup>89</sup>

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<sup>83</sup> United States Strategic Bombing Survey (ed.), *Effects*, Appendix Table 17, p. 218; Appendix Table 19, p. 219.

<sup>84</sup> Eichholtz was obviously not aware of this. See Eichholtz, *Kriegswirtschaft*, p. 373, Tab. 91.

<sup>85</sup> United States Strategic Bombing Survey (ed.), *Effects*, Appendix Table 29, p. 227.

<sup>86</sup> This number implies a lower limit because it refers to the Reich in the prewar borders.

<sup>87</sup> *Statistisches Handbuch von Deutschland*, p. 409.

<sup>88</sup> In addition, for 1943 and 1944 only aggregated data for the "Stationary engines and power units" sub-branch are available. Given that the shares of steam turbines, steam engine and locomobiles, as well as water turbines continuously decreased, we extrapolated this trend.

<sup>89</sup> When subtracting the USSBS export data from the USSBS sales data for 1938-42, it can be shown that these numbers are almost identical with those published by the *Wirtschaftsgruppe* at the beginning of 1944.

**Appendix table 1: Domestic sales of sub-branches of newly produced German machinery 1928<sup>a</sup>, 1936-44<sup>bc</sup> (m. RM)**

Sub-branches	1928	1936	1937	1938	1939	1940	1941	1942	1943	1944
1) Machine tools	143	352	448	508	605	788	877	886	742	727
2) Woodworking machinery	47	36	45	59	66	60	66	58	47	40
3) Expendable tools	59	108	163	197	239	330	379	378	293	351
4) Textile machinery	175	87	116	150	175	128	125	95	39	50
5) Sewing machines	88	58	66	76	91	52	37	29	25	17
6) Shoe and leather machinery	13	12	15	21	24	18	20	15	13	7
7) Farm machinery	248	298	355	436	521	485	479	414	400	226
8) Washing machines	29	11	14	16	18	15	12	11	6	9
9) Locomotives	66	70	67	81	185	244	311	401	616	438
10) Stationary engines and power units, category combustion engines	122	92	103	141	184	219	303	331	386	334
11) Stationary engines and power units, category steam turbine	.	32	43	59	73	69	77	68	64	57
12) Stationary engines and power units, category steam engine and locomobiles	.	10	14	16	16	16	16	14	13	10
13) Stationary engines and power units, category water turbine	72	6	8	14	12	9	10	9	9	6
14) Air compressors	156	181	242	326	405	424	467	457	430	447
15) Pumps	52	47	65	87	96	109	123	124	122	118
16) Smelter and rolling mill equipment	25	31	34	54	62	96	122	124	52	54
17) Heat treating ovens and blast furnaces	11	18	15	15	20	22	26	23	17	21
18) Foundry equipment	5	10	13	17	20	25	27	23	20	22
19) Construction equipment and machinery	173	165	197	277	313	284	318	309	236	303
20) Cranes, derricks and elevators	212	140	171	232	274	288	328	313	222	219
21) Paper producing machinery	35	11	16	25	29	22	19	15	9	11
22) Paper converting machinery	24	18	22	28	35	32	22	18	10	9
23) Printing presses	56	25	28	26	41	26	19	16	5	4
24) Food processing machinery	131	98	120	140	171	145	128	110	68	50
25) Chemical stills	121	135	164	253	261	272	316	305	221	205
26) Office machinery	70	110	141	175	212	155	110	97	74	29
27) Automates	4	10	11	11	9	1	1	0	0	0
28) Heavy and calculating scales	34	24	30	36	37	36	34	32	27	19
29) Testing machines	3	6	10	12	14	22	28	24	18	15
30) Safes and vaults	8	9	9	11	14	11	7	4	2	0
31) Valves and fittings	145	191	237	272	306	367	484	561	469	446
32) Gears and roller bearings	132	208	284	341	397	453	506	541	569	577
34) Fire fighting apparatus	12	15	21	24	27	47	71	113	138	113
35) Roller engraving plates	3	3	3	3	3	2	1	1	1	1
36) Railroad safety equipment	30	19	21	30	29	30	36	41	29	11

a BArch R 13 III/193, *Umsatz im Maschinenbau (Neufabrikation) mengen- und wertmaessig in den Jahren 1928 und 1938*, 8.7.1941.

b For 1936-1942, BArch R 3/1917, *Wirtschaftsgruppe Maschinenbau* to Dr. Stoffregen, 22.1.1944, pp. 19-63.

c For 1943 and 1944 (except row 32), United States Strategic Bombing Survey (ed.), *Effects*, Appendix Table 17, p. 227, Appendix Table 20, p. 220, Appendix Table 21, p. 220-1. For estimates of exports in 1943 and the numbers of row 32, see method described by the text.

## Appendix II

Import data shown by Appendix table 2 relies on information given by the *Statistisches Handbuch* and the *Statistisches Reichsamt*.

**Appendix table 2**      **Machinery imports, 1936-44<sup>a</sup> (m. RM)**

	1936	1937	1938	1939	1940	1941	1942	1943	1944
1) Expendable and farm tools	1,6	1,2	0,9	1,6	2,1	6,2	11,8	13,7	11,2
2) Machine tools and rolling mill equipment	6,2	5,7	8,2	10,3	13,5	44,4	61,5	59,7	48,9
3) Textile, shoe and leather machines	5,6	6,0	8,3	8,6	6,3	10,1	9,2	5,8	4,6
4) Farm machinery	2,6	2,2	2,0	2,6	3,4	3,7	5,5	5,7	4,6
5) Locomotives	0	0	0	0	0	1,6	28,6	47,0	38,6
6) Power machines	1,6	1,4	4,1	3,2	1,6	5,0	11,8	15,0	12,1
7) Pumps and air compressors	1,1	0,6	0,6	1,1	1,4	6,2	10,5	11,9	9,6
8) Cranes and derricks	0,5	0,1	0,1	0,2	0,3	1,4	3,5	4,6	3,7
9) Paper and printing machines	0,6	0,4	0,2	0,3	0,2	1,6	2,5	1,2	0,9
10) Office machinery	0,7	0,2	0,3	1,0	2,1	7,2	6,0	3,3	2,5
11) Food processing machinery	0,1	0,1	0,2	0,2	0,3	0,5	0,7	0,8	0,5
12) Other machines	11,3	9,0	12,7	20,8	25,7	52,1	99,1	115,6	95,1
13) Total import (sum of rows 1-12)	31,9	26,9	37,6	49,9	56,9	140,0	n.a.	284,3	n.a.
14) Total import ( <i>Wirtschaftsgruppe Maschinenbau</i> )	30,6	25,8	37,9	43,6	48,5	141,7	251,1	n.a.	n.a.
15) Total import ( <i>USSBS</i> )	n.a.	n.a.	37,9	43,6	48,5	98,4	173,0	232,2	234,3

a Row 1-13: for 1936 and 1937, *Statistisches Jahrbuch für das Deutsche Reich* 1938, p. 262; for 1940, *Statistisches Jahrbuch für das Deutsche Reich* 1941/42, p. 290; for 1939, 1941, 1943, *Statistisches Handbuch von Deutschland*, p. 408; for 1942 und 1944, own estimate. For the method, see text. For row 14, see BArch R 3/1917, *Wirtschaftsgruppe Maschinenbau* to Dr. Stoffregen, 22.1.1944, p. 26; for row 15, see United States Strategic Bombing Survey (ed.), *Effects*, Appendix Table 29, p. 227.

In 1942 and 1944, sub-branches numbers given by appendix table 2 are estimated, because total machinery imports in these years are not decomposed by the published sources. To estimate the import value of the respective sub-branches (according the classification in appendix table 2) for 1942, total import value provided by the *Wirtschaftsgruppe Maschinenbau* is multiplied by the mean of the relative import shares of the respective sub-branch of total imports in 1941 and 1943. To estimate the import value of the respective sub-branches for 1944, total import value provided by the *USSBS* is multiplied by the relative import share of the respective sub-branch on total imports in 1943. However, import categories cannot be decomposed according the sub-branches categories used by the *Wirtschaftsgruppe Maschinenbau* (as shown in appendix table 1). Thus, to estimate import

investments, we allocate import values respectively to inputs, industrial investments and investments outside of the industry. To avoid overestimating industrial machinery investment, cases of doubts (such as office machinery) are allocated either to inputs or to non-industrial investments.<sup>90</sup>

### Appendix III

**Appendix table 3: The impact of Wehrmacht machine tools purchase on the machinery production, 1938-43**

	I:	II:	III:
	Wehrmacht machine tools purchase (m. RM) <sup>a</sup>	Share of Wehrmacht machine tools purchase on total machine tools sales <sup>b</sup>	Share of Wehrmacht machine tools purchase on total industrial machinery investments <sup>c</sup>
1938	152	30	6
1939	251	41,5	8
1940	536	68	17
1941	594	67,7	17
1942	656	74	19
1943	608	82	22

a BArch R 13 III/290; BArch R 13 III/192, note, 31.7.1944, *Aufgliederung des Inlandsumsatzes 1943 in zulassungspflichtigen Maschinenarten nach Abnehmergruppen geschätzt.*

b I in percent of Appendix table 1, row 1.

c II in percent of table 4, row 10.

### Appendix IV

For 1943 we can calculate an upper and a lower limit of autarky as well as of Four Year Plan investments. The armament ministry provides information about construction investment of Four Year Plan branches (iron and steel; non-ferrous metals; fuels and chemicals, as well as powder and explosives), which amounted to 850 million RM.<sup>91</sup> Autarky machinery investment (572 million RM) is calculated by multiplying our estimated industrial machinery investment (table 4, row 10) with the

<sup>90</sup> As industrial investments are considered: Textile, shoe and leather machines; food processing machinery; cranes and derricks; machine tools and rolling mill equipment. As inputs are considered: pumps and air compressors; other machines. As non-industrial investments are considered: expendable and farm tools; farm machinery; locomotives; paper and printing machines; office machinery; power machines.

<sup>91</sup> BArch R 3/1960, *Bauinvestitionen 1943, gegliedert nach den Fertigungen des Gesamtaufwandsplans der deutschen Volkswirtschaft Großdeutsches Reich ohne Protektorat*, 23.7.1944, p. 165.

share of autarky machinery investment of total machinery investment (21%), which can be computed on the basis of information given by the armament ministry's estimate regarding machinery investment mentioned above.<sup>92</sup> In the sum of construction and machinery investment (1422 million RM), however, self-provided equipment and equipment investment except machinery are not included. Thus, this estimate represents a lower limit. Assuming for the autarky branches a construction-equipment investment ratio of 25%, as calculated by the *Statistisches Reichsamt* for the chemical, fuel and potash industry in the years 1935-8, an upper limit can be computed (about 3400 million RM). This may be an upper limit because it seems probable that due to air raid protection also in these branches the ratio may be increased compared to the prewar period. Thus, we assume that the mean of the upper and the lower limit (2411 million) may be a realistic approximation of the true value. Taking into consideration that according the data provided by the armament ministry machinery investments in powder and explosive plants amounted to 3 million RM in 1943 (construction investment did not occur), we can conclude that autarky investments represent 2408 million RM.

## **Appendix V**

Armament investments from 1934 to 1939 are calculated as the sum of the numbers provided by table 7, row 6 on the one hand, and on the other hand of navy as well as army armament investments of private companies, which until the end of the peacetime period amounted to at least 500 million RM.<sup>93</sup> The latter amount is allocated to the single years according the growth rate of army leasing plants. Again, given that data about navy leasing plants are not available, this method leads to an underestimate of munitions branches' investment during the period considered. However, as already mentioned, the investment of the latter were small. Armament investments in 1940 and 1941 are calculated as the sum of investments in army leasing plants and in air force munitions plants.<sup>94</sup>

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<sup>92</sup> BArch R 3/1960, *Gliederung der Maschineninvestitionen nach den Fertigungen des Gesamtaufwandplans, verbessertes Ergebnis*, 15.9.1944, pp. 173-4.

<sup>93</sup> R 2/59967, *Liste über Geheimdarlehen*, pp. 4-6.

<sup>94</sup> For army leasing plants see Hopmann, *MONTAN*, p. 121 Tab. 14; for air force munitions plants see BArch R 2/5551, *Übersicht über die Investierung und Finanzierung der Luftwaffenrüstungsindustrie*, p. 17. At first glance, the latter document

Further, based on a rough estimate regarding private industries' army and navy armament plants' investment, an amount of 100 million RM per year is added.<sup>95</sup> Also for investments in leasing machines an annual lump sum of 50 million RM is added.<sup>96</sup> When estimating armament investments in 1942, it is assumed that the ratio between armament industry's machine tools investments and total armament investments (except powder and explosives investments) corresponded to those in 1940 and 1941 (about 37%), resulting to an amount of 1773 million RM and by adding powder and explosives investments to a sum of 2498 million RM. The same method is used for estimating armament investments in 1943, which amounted to 1793 million RM.<sup>97</sup> Also for these years, the lump sum of 150 million RM is added.

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suggests investments of 5.2 billion RM between the beginning of the war and the end of 1941 (as also sometimes claimed in the literature. See for example Eichholtz, *Kriegswirtschaft*, p. 526). Yet, a closer inspection shows, that of this number an amount of 2500 million RM was planned; only about 2700 million RM was already invested. The air force plant investment numbers in 1940 and 1941 are splitted up into the single years according the relation of air force machine tools purchases.

<sup>95</sup> This estimate relies on the fact that we have information about investment loans for private army munitions producers provided by a special public bank, the *Heeresrüstungs-AG*, a subsidiary of the *Industriebank AG*. These loans amounted to only 320 million RM until 1945. Further, the *Industriebank* provided investments loans to private army and navy munitions producers, which amounted to 650 million RM. Boelcke, *Die Kosten*, p. 129; Cassier, *Unternehmerbank*, p. 147; BArch R 2 Anh./37, p. 30. However, a part of the latter loans were used for financing autarky plants (For an example, see Scherner, 'Verhältnis'). Thus, we assume an armament industry's investment amount financed by all these loans, which amounted to 500 million RM, which are allocated in equal shares to the armament investments between 1940 and 1944.

<sup>96</sup> This is based on the observation that still between October 1943 and September 1944 at least about 50 million RM were invested in leasing machines. BArch R 3/183, p. 213.

<sup>97</sup> The validity of the 1943 estimate is proven when calculating armament investments in 1943 based on the information of the armament ministry, employing the same method as in the case of autarky's investment estimate for 1943. In the sum of construction and machinery investments (1512 million RM), however, self-provided equipment and equipment investment except machinery are not included. Therefore, this estimate represents a lower limit.



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