

# Cologne Economic History Paper

Universität zu Köln

Seminar für **Wirtschafts- und  
Unternehmensgeschichte**

No. 3 (2012)

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A Co-evolutionary Approach to the Rise of the  
German Pharmaceutical Industry 1871-1914

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**Ed.: Carsten Burhop**

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**Building the “World’s Pharmacy”:  
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1871-1914**

**Tobias Cramer\***

**Abstract**

The German pharmaceutical industry dominated global output and new drug creation from the late 19<sup>th</sup> century to World War I. German firms focused increasingly on innovative medicines with a high scientific content which are supposed to generate a high value-added. A main contribution of this paper is thus a detailed analysis of the composition and profitability of each company’s product portfolio. Monopoly profits were not only assured by intellectual property protection but also by intensifying cartelization. This paper challenges the interpretation that the industry’s research capabilities alone explain the rise of the German pharmaceuticals industry by analyzing a co-evolutionary process of firms, science and institutions.

**JEL-Classification**

L 65, N 83, O 32

**Keywords**

Pharmaceutical Industry, Germany; pre-1913; Technological Innovation

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## I. Introduction: Co-evolution of pharmaceutical firms, science and institutions in Germany

Corporate and industrial development in high-tech industries has been explained in the management and economics literature mainly by two diverging approaches: First, firm-based resources and capabilities embodied in managers are identified as key drivers in adapting corporate organizational arrangements to fit the demands of the environment.<sup>1</sup> Second, external institutions that support industrial growth are considered essential for a realistic portrayal of the industrial development.<sup>2</sup>

A protagonist in business history of the first and most influential approach is Alfred DuPont Chandler.<sup>3</sup> To understand the growth of modern chemical and pharmaceutical industries he presents a list of the world's largest pharmaceutical producers in 1993 and describes their evolution—their paths of learning—in the 20th century.<sup>4</sup> With respect to Germany, the path defining firms considered by Chandler are *Bayer*, *Hoechst* and *BASF*. It has been noted that German pharmaceutical companies had a technological advantage at home and even more abroad after the First World War.<sup>5</sup> According to Chandler those first movers remained successful because they built 'integrated learning bases' (knowledge and capabilities) and reinvested generated profits in the development of new products. This raised market entry barriers for followers, facilitated the leaders to define their 'strategic boundaries' and overcome 'limits to growth'. However, Chandler's firms rely primarily on internal sources to develop their 'learning bases' and little attention is paid for example to the role of university-based research or to institutional conditions, such as government regulation or jurisdiction.<sup>6</sup>

The second stream is embodied by Richard R. Nelson with regard to highly innovative sectors. According to Nelson national innovation systems determine the innovative performance of national firms.<sup>7</sup> The characteristics of a nation's system of education, the relations between labour and management, financial markets and corporate governance structures have strong influence on technological advance that managers can foster in

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<sup>1</sup> Barney, 'firm resources'; Teece et al. 'Dynamic capabilities'; Cf. Järvinen et al. 'Alternative Paths'

<sup>2</sup> North, *institutions*; Nelson, 'Capitalism', 'co-evolution', 'rapid economic progress', cf. Mowery, 'Alfred Chandler'.

<sup>3</sup> Chandler, *strategy*, Chandler, *visible hand*, Chandler, *scale and scope*; Cf. Cassis, *big business*.

<sup>4</sup> Chandler, *Shaping*.

<sup>5</sup> Cantwell, 'globalisation'.

<sup>6</sup> Mowery, 'Alfred Chandler', p. 502; Kyle, 'Shaping' [book review].

<sup>7</sup> Nelson/Winter, *Evolutionary Theory*; Nelson, *Innovation Systems*; Freeman 'national systems'.

their companies.<sup>8</sup> He introduces the term “social technology” to describe the historical rise of the M-organizational form in big business, the rise of the dye business and the rise of the pharmaceutical industry.<sup>9</sup> To make this outstanding approach with its highly increased complexity viable for historical research the number of case studies is often limited to a few firms. It has not yet generated insights into the development of an entire leading high-tech branch in a particular nation.

Murmann, in contrast, opts for a combination of both approaches. He analyses the dye sector in order to understand how German chemical firms acquired technological and other competitive advantages before 1914.<sup>10</sup> He describes a co-evolutionary process of firms, technology and national institutions as key determinants for German leadership in this industry.<sup>11</sup> His study has had a huge impact on this field of research.<sup>12</sup> Despite the importance of his concept, the empirical basis of his study largely consisted of published sources. The German business historian today however benefits from the fact that he can get access to the primary sources of most leading German chemical companies because firms either survived, merged or transferred their archival material to public archives. I would like to contribute to a profound understanding of the rise of a leading branch in the German chemical industry relying mainly on primary sources.

Considering that dye and pharmaceutical industries in Germany were closely connected a co-evolutionary approach is also highly promising to deliver insights on the extraordinary growth of the latter branch.<sup>13</sup> This co-evolutionary research design comprises three essential areas of mutual influence between firms and their surrounding: Science, legislation/jurisdiction, and cooperation.<sup>14</sup> The pharmaceutical industry provides a helpful case study because the branch was not only a leading

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<sup>8</sup> Yoon/Hyun, ‘Concept’, p. 9. This approach originated from both evolutionary economics and institutional theory. For the theories cf. Dosi/Winter, ‘economic change’; Nelson/Sampat ‘making sense’.

<sup>9</sup> Nelson/Sampat ‘making sense’; Nelson ‘rapid economic progress’.

<sup>10</sup> Murmann, *Knowledge*.

<sup>11</sup> The argument briefly is: Germany had a superior higher educational system in organic chemistry, this generated plenty of skilled chemists who founded start-ups, a fierce competition (high exit frequency) followed and only the best (which continuously hired chemists) survived. Furthermore the absence of a patent law (before 1877) helped the industry to grow and when it was already mature, patent protection ensured its interests. Murmann, *Knowledge*, p. 51, 85, 212.

<sup>12</sup> In a recent publication (‘Coevolution’) Murmann advances his theory of coevolution by highlighting three mechanisms that drive coevolution of both the dye industry and organic chemistry as an academic discipline: a) exchange of personnel, b) commercial ties, and c) lobbying.

<sup>13</sup> Regarding research Burhop (‘Pharmaceutical Research’) highlights the connections of both branches.

<sup>14</sup> My design is in accordance with Murmann’s recent categories (see footnote 13). Nevertheless important differences existed between dye and pharmaceutical industries in terms of the third mechanism (lobbying). Here academia on the one hand didn’t engage in the same manner to help the industry obtain favourable institutions as the trademark law. Industrial lobbying to foster academic/research conditions on the other hand were more based on individual than on collective actions of entrepreneurs (as Weinberg helping Ehrlich, see Cassella in the appendix).

science-based national branch but also dominated world markets in 1913.<sup>15</sup> The Wilhelmine Empire was consequently being called the “World’s Pharmacy”.<sup>16</sup>

Therefore, my paper has two aims. First, it intends to describe the pharmaceutical industry’s structure and its evolution during the German Empire in more detail since Chandler’s selection of companies was somewhat eclectic and does not represent the entire industry. Nevertheless the big businesses described by Chandler have certainly been among the industry’s leaders. However, it has never been empirically proven if they were the most innovative players and if innovativeness meant a leading position in terms of profitability. In this article, I investigate whether the path-definers were really the leading German pharmaceutical firms at the beginning of the 20th century. For this end, in section one of this paper I present a similar ranking to the one offered by Chandler for German pharmaceutical firms in 1913. It is shown that mainly three categories of firms may be distinguished according to their origins: former pharmacies, former dye companies and former drug merchants. *Merck* led the group of former pharmacies, *Bayer* those of the former dye firms and *Gehe* those of the traders. This implies that there was no prototypical “path of learning” for all companies in the industry but rather three different ways of evolution.

Along with characteristics of firms, I furthermore depict market characteristics and institutions to understand the factors supporting the rise of the German firms on their home market. The rise of the modern chemical industry is often termed the “Second Industrial Revolution” with an incorporation of science, especially chemistry, into production as a key determinant. Research for pharmaceuticals relies on technological advances not only in organic chemistry but also in the medical science.<sup>17</sup> In regard to institutions both kinds of intellectual property rights, patents and trademarks, play an important role. This is even more the case as scientific names of chemical substances are often harder to remember than catchy pharmaceutical brands.<sup>18</sup> Finally, an obligatory public health insurance stimulated pharmaceutical demand. Soon after its foundation in

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<sup>15</sup> According to Bartmann ( *Tradition*, p. 316) national shares of world pharmaceutical exports were: GER: 35.6%, GB: 24.5%, US: 14.8%, CH: 4.4%. Some authors also claim that up until World War I German pharmaceutical industry produced approximately 80% of the world’s pharmaceutical output. Henderson et al., ‘Industry’, p. 271; Cf. Schmitt, *Industrie*, p. 167.

<sup>16</sup> Bartmann, *Tradition*, p. 20.

<sup>17</sup> For the importance of medical and chemical sciences for the scientification of pharmaceutical production see Schmitt, *Industrie*, p.37ff.

<sup>18</sup> Jennewein, *Intellectual Property*, p. 47; Cramer, *Rückkehr*, p. 1; cf. Wilkins, ‘Intangible Asset’, p. 78. In 1994 Bayer paid 1 billion dollar to recover the right to sell Aspirin and other OTC drugs under its own name and brand.

1883, healthcare expenditures quickly increased which stimulated a rise both in the number of doctors and in pharmaceutical production.<sup>19</sup>

After the unification of the German Empire in 1871 medical science prospered, especially at the newly established and financially highly supported Strasbourg Imperial University.<sup>20</sup> An important role for the development of new pharmaceuticals plays pharmacology/physiology as a subfield of medical science.<sup>21</sup> A close link between corporate research and application departments significantly raises efficiency in the on-going research process and generates information for clinical testing.<sup>22</sup> The laboratory researcher, a chemist, quickly needs feedback from a pharmacologist if the invention has undesired side-effects to avoid wasting time on improper substance categories.<sup>23</sup> Clinical trials as the next step in the invention process could furthermore be accelerated if basic information on product properties was available from the very beginning.<sup>24</sup> Big corporations in German pharmaceutical industry soon recognized the value of physiologic data and thus complemented their research laboratories by early internal or external physiological testing.<sup>25</sup>

The institutions in Wilhelmine Germany certainly had a large impact on the pharmaceutical industry's development.<sup>26</sup> If they were not beneficial, it was lobbied to change them or firms opted for self-regulation. Nevertheless, neither institutions nor corporate structures alone can explain the industry's success as it takes managers who use or develop resources to take advantage of opportunities in the given market environment.

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<sup>19</sup> Expenditures for pharmaceuticals more than doubled from 1885 (8.1 M million) to 1891 (16.4 M million). For number of insurants, doctors, inhabitants and health care expenditures see Landgraf-Brunner, *Auseinandersetzungen*, p. 84ff.

<sup>20</sup> Hickel, 'Grundlegung', p. 202; Hickel, 'Arzneimittelforschung', p. 143; Wimmer, *Wir haben*, p. 34f.

<sup>21</sup> Hickel, *Grundlegung*, p. 199ff. The city had been conquered by the Germans in 1871. The university was the only Imperial University institution (Reichsanstalt) in Germany. A protagonist in medical application of pharmaceuticals was the Strasbourg physician Oswald Schmiedberg. He discovered correlations between ingredients and their therapeutic effect Huhle-Kreutzer, *Entwicklung*, p. 85f.

<sup>22</sup> Industrial pharmacologists carried out experiments with healthy animals to find out efficient, toxic and lethal doses by comparing the new substance's properties with a reference product. Clinical testing with ill people was always done externally by renowned MD's. Cf. Farbenfabriken Bayer, *Geschichte*, p. 419.

<sup>23</sup> At Merck it took several months for externally generated pharmacologic results to get back to the laboratory whereas at Bayer it worked within weeks due to an internal pharmacologic research. Jahresbericht wissenschaftliches Labor 1909, p. 8, EMA F3-13d; Wimmer, *Wir haben*, p. 140.

<sup>24</sup> Merck, *Entwicklung*, p. 36 also highlights the connection of chemical and medical science. However he sees the importance of medical science more in clinical rather than in pharmacological testing.

<sup>25</sup> Bayer employed a pharmacologist in 1890 for the first time. Hoechst employed external pharmacologists and Schering carried out physiologic animal experiments from 1902 on. Wimmer, *Wir haben*, p. 118, 125, 175f, 208f. Huhle-Kreutzer, *Entwicklung*, p. 143.

<sup>26</sup> During the war French and British chemists discussed about the determinants of German success and how to copy it. The discussion comprised most institutional aspects discussed here. The essays were translated and published in *Die chemische Industrie*, Vol. 39 (1916). See also Schmitt, *Industrie*, p. 125.

By the end of the 1880's the common competitive strategy of most firms was similar to the one pursued by German dye firms at the beginning of their growth: imitation.<sup>27</sup> Although the German patent act of 1877 protected pharmaceutical production processes, most of the early new synthetic pharmaceuticals could not be patented, like Antifebrin, Phenacetin or Sulfonal. Therefore the companies relied more on trademark (brand) protection by creating phantasy names. Curiously German producers were disadvantaged on their home market by German trademark law compared to foreign competitors: They were not allowed to register word marks (brands) and thus needed to add graphical icons. Another disadvantage was that trademark protection was limited to labels and excluded protection in announcements, e.g. price lists. This provoked the industry to lobby for reform. Although all companies were attracted by the high profitability to be yielded with specialities they were not the only products sold by German pharmaceutical companies.<sup>28</sup> Section two analyses the size of each company's speciality business and compares different product categories in terms of profitability. This helps to explain why lobbying and cartelization activities were especially strong to protect specialities.

In the first half of the 1890's the strategy was changed in favor of a development of patented and trademarked specialities.<sup>29</sup> This was stimulated by changed legal institutions such as renewed acts of patent (1891) and trademark protection (1894) or different Supreme Court decisions. To safeguard monopoly profits an important Supreme Court decision, which legalized cartels (1897), encouraged cooperation amongst German manufacturers.<sup>30</sup> Thus the paths of learning also implied a system of worldwide cartelization, syndication and lobbying efforts in the enlargement/enforcement of intellectual property rights.<sup>31</sup>

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<sup>27</sup> Phenacetin was produced after 1888 by Riedel, Knoll, Hoechst, AGFA and Roche. From 1896-1908 nearly a dozen companies produced Phenacetin. Cf. Altschul, 'Wortschutz', p. 88; 'Nochmals zum Wortschutz', p. 619; Wenzel, *Adressbuch*, Part II [products], different volumes.

<sup>28</sup> Pharmaceutical products which were protected by patents and trademarks and which were offered to the public in a ready-to-use package were called "specialities". Horn, *Absatzorganisation*, p. 5.

<sup>29</sup> For an introduction into the evolution of specialities see Stader, *Arznei-Spezialität*, p.1f.

<sup>30</sup> Pohl, 'Entwicklung', p. 215.

<sup>31</sup> This article focusses exclusively on the situation in Germany, international issues will be treated in a separate paper.



## II. Three main groups of manufacturers in German big pharmaceutical business

Some of the big players are well known whereas others have only recently been studied while a few still lack scientific analysis at all.<sup>32</sup> One aim of this paper is therefore to contribute to a better understanding of pharmaceutical world market leaders before the end of the First World War by collecting fundamentals on all mayor German players.<sup>33</sup> Thus, this study lays the groundwork for further and more detailed studies. It analyses for the first time the pharmaceutical businesses of five important firms: *AGFA*, *Kalle*, *Cassella*, *Heyden* and *Zimmer*. At the beginning of the Wilhelmine Empire only a few companies produced pharmaceuticals whereas in 1913 both the number and the size of producing entities had increased immensely.

*Table 1: The largest industrial pharmaceutical producers in Germany, 1872 and 1913 (in M millions of pharmaceutical-product revenue)<sup>34</sup>*

Rank	Company	Revenue (M millions)	Rank	Company	Revenue (M millions)
1	Merck	2.6	1	Merck	26.2
2	Boehringer M	1.2	2	Bayer-Pharma	21.4
3	Riedel	0.5*	3	Heyden-Pharma	15.1
4	Trommsdorff	0.4	4	Hoechst-Pharma	12.9
5	Heyden	0.1*	5	Riedel-Pharma	11.8
			6	Gehe	10.6
			7	Boehringer M	10.1
			8	Knoll	4.9
			9	Zimmer	3.5°
			10	Boehringer I-Pharma	2.7
			11	Schering-Pharma	2.7
			12	AGFA-Pharma	0.6
			13	Kalle-Pharma	0.6

\* = 1875

° = 1912/1913

How does this picture fit into the wider context of the world's pharmaceutical industry? We might first of all have a look at the second big group of 'path definers', the Swiss competitors. Biggest among them was Hoffmann-La-Roche (*Roche*) in Basle which possessed a subsidiary bigger than its headquarters in the nearby German town of Grenzach and was thus sometimes counted as a German company. *Roche's* consolidated 1914 sales was 19.1 CHF million (=15.3 M million), followed by *Ciba* with a

<sup>32</sup> Recently: Godley/Hughes, 'E. Merck' (forthcoming); Jones/Lubinski, 'Managing Political Risk'; Vollmann, *Eigenständigkeit*; Burhop, 'Pharmaceutical Research'; Ziegler, *Familie Jobst..* For 'classical' literature on specific companies see the annexed business historical part.

<sup>33</sup> This material consists of both archival sources and printed material such as address books, hand books of German joint stock companies, corporate anniversary books, exposition catalogues, and contemporary pharmaceutical journals.

<sup>34</sup> For sources and data selection see appendix. Due to the gold standard exchange rates remained nearly constant throughout the German Empire at 4.2 (USD) and 20.4 (GBP). Changes in the price level from 1872-1913 may be estimated using Hoffmann's NNP Deflator. In 1872 it was 86.5% of the 1913 level. Cf. Hohls, 'sectoral structure', p. 226.

pharmaceutical sales volume in 1911/1912 of 3.8 CHF million (=3.0 M million).<sup>35</sup> Among the British companies *Allen & Hanbury* was market leader in 1914 with sales of £508,000 (= 10.4 M million) followed by *Burroughs Wellcome* with £454,800 (= 9.3 M million) and *May & Baker* £302,500 (= 6.2 M million).<sup>36</sup> Looking at the US market leaders in pharmaceuticals shows that *Merck & Co.*, the US-subsubsidiary of *E. Merck* in Darmstadt, had own sales—which were not included in the parent companies' revenue—of 3.9 \$ millions (=16.4 M million) in 1913 whereas the other two largest US pharmaceutical companies *Smith, Kline & French* and *Parke, Davis* had already reached comparable sales volumes ten years earlier.<sup>37</sup> Between the German and the British pharmaceutical industry there seems to have been a separation of certain 'spheres of economic interest'.<sup>38</sup> It has often been stated that the German pharmaceutical industry was highly export oriented.<sup>39</sup> Nevertheless Germany remained the major market: close to 40 percent of sales were made in the home market.<sup>40</sup>

A closer look on Tab. 1 seems to confirm Chandler's thesis that those leading companies which had a prominent position in the early years of the German pharmaceuticals industry understood well to use their first mover advantage (FMA) and stayed among the top ten producers in 1913 with one exception, *Trommsdorff*.<sup>41</sup> Nevertheless 1872 numbers may only serve as a vague approximation to reality due to gaps in data availability and consistency.<sup>42</sup> Data for 1913 is more reliable, though not perfect according to modern standards.<sup>43</sup>

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<sup>35</sup> Roche, *Traditionally*; Straumann, 'Farbstoffe gegen Rohstoffe', p.291; Zeller, *Globalisierungsstrategien*: For Ciba's/Roche's products cf. Vershofen, *Wirtschaftsgeschichte*, p. 60f; Peyer, *Roche*, p. 49.

<sup>36</sup> Robson, 'British pharmaceutical industry'; Corley, *Beecham Group*. Cf. Williams, *British Pharmaceutical Industry*.

<sup>37</sup> Both about \$3 million. Galambos, *Values and Visions*; Liebenau, 'Scientific Ambitions'; Mahoney, *Merchants of Life*.

<sup>38</sup> Robson, 'The British pharmaceutical industry'; Liebenau, 'Ethical business'.

<sup>39</sup> Wimmer, *Wir haben*, p. 107.

<sup>40</sup> As mentioned before the international business of German pharmaceutical manufacturers will be treated in a separate paper.

<sup>41</sup> This is only partly true because the largest part of Trommsdorff's business was acquired by Merck in 1893 (see annex for a business historical part).

<sup>42</sup> Inconsistencies in data collection exist across companies. Merck's revenue is an average of a two year joint balance (1872-1874) for plant and pharmacy and includes turnover in products and packing between the two entities. Trommsdorff's data comprises only products sold by the plant. Boehringer Mannheim's number is the value of the 1872 yearly production of its most important product, quinine. Riedel's numbers were given as a share of 1913 sales without further information. Other companies' data (e.g. Gehe and Zimmer) is unavailable.

<sup>43</sup> First, some companies (Bayer, Hoechst) seem to have given consolidated worldwide sales (including subsidiaries/foreign production) whereas others (Merck, Knoll, Riedel, Gehe, Boehringer Mannheim (M), Heyden) only listed their German produced supplies sold on the world market. Even if sales data is available for subsidiaries (e.g. Merck & Co., USA) equalizing is impossible without further information. Merck & Co. e.g. was also Boehringer Mannheim's sales agent in the US from 1908 on. Unfortunately no data survived on the size of Merck & Co.'s sales generated with genuinely E. Merck's or Boehringer's products. Second, fine chemicals were also used for medical purposes which makes a separation between pharmaceuticals and

Tab. 1 also shows that various traditionally dye producing firms had successfully diversified into the field of pharmaceuticals by 1913. Thus, another determinant for corporate success in the German pharmaceutical industry seems to have been previously acquired capabilities in a closely related field of organic chemistry, dyestuffs.<sup>44</sup> Third, at least four top ten companies diversified into pharmaceutical production from wholesale trading. Therefore market knowledge and marketing networks seem to have been a third determinant of corporate success.<sup>45</sup>

According to our determinants of corporate success the companies in Tab. 1 can be subdivided in three main categories of firms<sup>46</sup>: The first and mostly highlighted origin of an industrial pharmaceutical production was a small scale production (or sale of non-auto produced substances) typical for pharmacies all over the world. According to mainstream history of German pharmaceutical firms this group is composed of *Merck*, *Trommsdorff*, *Riedel* and *Schering*.<sup>47</sup> Those were the early movers in pharmaceutical production in Germany.

Chronologically they were closely followed by a second group of firms who diversified into production from a sales stage. Those drug wholesalers comprised *Boehringer Mannheim* (M), *Zimmer*, *Gehe* and *Knoll*.<sup>48</sup> The third and biggest group were the formerly dye producing companies such as *Hoechst*, *Kalle*, *Bayer*, *AGFA* (*BASF* and *Cassella*).<sup>49</sup> Last, two exceptional ways were taken by *Boehringer Ingelheim* (I) and *Heyden*. The members of each group are now briefly described. A detailed business historical part of all leading German pharmaceutical manufacturers and two other important companies not mentioned in Tab. 1 (*BASF*, *Cassella*) can be found in the appendix.<sup>50</sup>

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chemicals impossible (Merck), if the latter were not exclusively used for purposes like photography or celluloid production (Schering) or tanning (Boehringer Ingelheim).

<sup>44</sup> Cf. Burhop, 'Pharmaceutical Research'.

<sup>45</sup> Chandler, *Visible Hand*, had identified functional integration and product diversification as essential for long term success of leading American corporations. Kocka/Siegrist, 'Industrieunternehmen' found that although BASF, Bayer and Hoechst were already among the biggest German corporations in 1887 they were only modestly diversified in comparison with firms from other branches. Their functional integration – especially into distribution – however was already obvious in 1887.

<sup>46</sup> Merck, *Entwicklung*, p. 14; Bernsmann, 'Arzneimittelforschung', p. 448f confirm this categorization.

<sup>47</sup> Huhle-Kreutzer, *Entwicklung*. Merck and Riedel are difficult cases: Although both companies started with a pharmacy, Riedel diversified into large scale wholesaling instead of production and could thus also belong to the 2<sup>nd</sup> group. Merck started both production and wholesaling at merely the same time.

<sup>48</sup> Zimmer and Knoll are here counted as former wholesalers due to the fact that in both cases the founders worked at famous wholesaling businesses (Gehe, Jobst) before starting production. In the literature they are often differently grouped. For further details see appendix.

<sup>49</sup> Interestingly the Swiss dye company Sandoz entered the pharmaceutical business nearly at the same time (1917) as Cassella. Zeller, *Globalisierungsstrategien*, p. 116.

<sup>50</sup> Both firms sold pharmaceuticals at some stage of the German Empire but not in 1913 and were thus excluded from Tab. 1.

*Former pharmacies:* Biggest among all drug manufacturers in general and among pharmacies in particular was Chemische Fabrik E. Merck OHG, Darmstadt near Frankfurt (*Merck*). In 1668 the pharmacist Friedrich Jacob Merck acquired a pharmacy in Darmstadt and his descendant Heinrich Emanuel Merck together with his sons started the industrial production of alkaloids in 1827.<sup>51</sup> *Merck* also started wholesaling of drugs, which rose to make 1/3 of overall sales at the beginning of the 20<sup>th</sup> century.<sup>52</sup> Although *Merck* developed own specialities the company was more a large pharmacy than a speciality producer (Tab. 5).<sup>53</sup> *Merck* bought nearly the whole business of Chemische Fabrik H. Trommsdorff KG, Erfurt (*Trommsdorff*) in 1893, so that the core of the latter company ceased to exist.<sup>54</sup>

The second biggest former pharmacy was J. D. Riedel AG, Berlin (*Riedel*). Johann Daniel Riedel founded his company, then a pharmacy, in 1814 in Berlin. In 1827 he started to produce quinine but soon failed.<sup>55</sup> Instead he established a drug wholesaling business. The company started to produce Phenacetin and Sulfonal at the beginning of the 1890s.<sup>56</sup> *Riedel* also produced an artificial sweetener Dulcin (1892). In 1913 specialities accounted for 19.5% of total sales.<sup>57</sup>

Last among former pharmacies in big German pharmaceutical business was Chemische Fabrik auf Actien vorm. E. Schering AG, Berlin (*Schering*). Ernst Schering bought a pharmacy in 1851 and a few years later the production of fine chemicals mostly for photography started.<sup>58</sup> After *Schering* was incorporated (1871) the company produced primarily salicylic acid. After the salicylic acid patent (jointly exploited with *Heyden* after 1877) voided in 1889, Schering started to produce specialities. In 1913 specialities accounted for 15.9% of total sales.<sup>59</sup>

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<sup>51</sup> Burhop, 'Pharmaceutical Research', p. 480; Galambos/Sturchio, 'Transnational Investment', p. 228.

<sup>52</sup> Tätigkeitsbericht W. Conzen, EMA F6/7, p. 24. Merck listed 10.000 products in its 1890 price list. Bernschneider-Reif et al, *Was der Mensch*, p.53. In 1898/1899 wholesaling generated 37% of overall sales. Jahresbericht 1898-1899. EMA F3/3a 001-030; Cf. Stube, *Ueber Arten und Formen*, p. 284.

<sup>53</sup> Bartmann, *Tradition und Fortschritt*, p. 102 calls Merck a 'large pharmacy' (Großapotheke) and attributes the relative loss of competitiveness to the big and lower profit-making product portfolio.

<sup>54</sup> In response Trommsdorff's owner (C. Lagemann) established a company under his own name in Aachen in 1892. After Trommsdorff's headquarters was moved to Aachen (1905) both companies shared the same directors and resided under the same address/phone number. Wenzel, *Adressbuch*, Vol. 10, p. 271, 439.

<sup>55</sup> Huhle-Kreutzer, *Entwicklung*, p.173.

<sup>56</sup> Notizen des Aufsichtsratsvorsitzenden Ernst v. Eynern zur Firmengeschichte, p. 100. BAL 1/5.2.

<sup>57</sup> Protokollbuch J. D. Riedel Aktiengesellschaft 1913-1918, p. 53. HCAS P4; Propaganda Boehringer an IG, 23.08.1915, Übersicht J. D. Riedel, EMA H5/48b.

<sup>58</sup> Huhle-Kreutzer, *Entwicklung*, p. 185ff. Pharmaceuticals only represented only a small part of the product portfolio

<sup>59</sup> Total speciality sales 1913: 2.691 M million. List dated 02.05.1929. SchA B0-549/1. Atophan made 7.4% of total sales in 1913, followed by Urotropin (4.3%) and Medinal (1%). To calculate Schering's overall pharmaceutical sales (including not only specialities) for 1913 is very difficult with existing sources. No numbers survived e.g. for salicylic acid sales. Taking overall sales (including fine chemicals) is not viable because these include huge photochemical sales and camphor which other companies (Bayer, AGFA,

*Former drug wholesalers:* The leading company in this group and still the biggest drug wholesaler in 1913 was Gehe & Co. AG, Dresden (*Gehe*). *Gehe* was founded in 1835 by the merchant Franz Ludwig Gehe. The company opened a plant for the extraction of alkaloids in 1866. Galenicals however only generated 6.9% of total sales as late as 1910.<sup>60</sup> In Germany *Gehe* supplied both smaller wholesalers (2/3) and pharmacies (1/3).<sup>61</sup> Among the few specialties were Ureabromin (1910), Agobilin (1913) and Calmonal (1915).<sup>62</sup>

The second biggest company coming from a wholesaling background was C. F. Boehringer & Soehne GmbH, Mannheim (*Boehringer M*). The company was founded in 1859 in Stuttgart by the drug trader Christian Friedrich (C. F.) Boehringer and his two sons to start the production of quinine.<sup>63</sup> To expand production the company moved to a bigger site in Mannheim in 1872. *Boehringer M* mostly produced alkaloids. First specialties were Eseridin (1888), Ferratin (1892), its liquid form Ferratose (1894) and Lactophenin (1894).<sup>64</sup> Still in 1916 non-patented pharmaceuticals generated 53.5% of total sales compared to 9.2% for specialties.<sup>65</sup>

Third largest former drug wholesaler in 1913 was Knoll & Co. OHG, Ludwigshafen near Frankfurt (*Knoll*). *Knoll* was founded in 1886 by the chemist Dr. Albert Knoll, and the merchants Hans Knoll and Max Daege for the extraction of opiates, mostly Codeine.<sup>66</sup> The three founders had all previously been working for the drug wholesaler *Gehe*.<sup>67</sup> Specialties were e.g. Theobromin (1889), Diuretin (1894), Tannalbin (1895),

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Boehringer M) balanced differently. But Formalin, a disinfectant (369K M) and pure medical camphor (193K M) could be added. Cf. Pharmazeutische Zeitung Vol. 66. (1921), p. 912; Kobrak, *National Culture*, p. 367f.

<sup>60</sup> Galenische Präparate, Gehe to I.G. Pharma, 17.03.1913. EMA H5/33. For 1912 it's even less (5.9%). In the first half of 1910 specialties only generated 1.5% of sales. Letter Gehe to Fuchs, 19.10.1910, EMA H5/10a.

<sup>61</sup> Gehe an I.G. Pharma, 18.02.1910. EMA H5/10c.

<sup>62</sup> Gehe's partners of the IG Pharma (see below) proposed Dresden to introduce new easily made products like medical chocolates, pocket pharmacies or signed them some products over e.g. Tannyl, Triferin (Malthyl) or Triferrol by Knoll. Cf. Freia-Liste, SchA S1/006. Spezialitäten – Betrieb Dresden 06.11.1911, p.2. EMA H5/30

<sup>63</sup> C.G. Boehringer was a merchant and C.F. a pharmacist. *Denkschrift der C. F. Boehringer*, p. 3. Siebler, *Menschen*, p.16; Gedenkblatt C.F. Boehringer & Soehne 1859-1909 RDA without shelf number. The former plant of Simeons, Ruth & Co. in Hoechst was bought in March 1859, but facilities were brought to Stuttgart where quinine production started in 1861

<sup>64</sup> *Denkschrift der C. F. Boehringer*, p. 29. Cf. Schmiedeberg, 'Ferratin'.

<sup>65</sup> [C.F. Boehringer Soehnel, I.G. Jahres-Bericht -1917-, p.3, EMA R15/14b. The second largest product group, technical products, had a share of 28% of total sales whereas odorants accounted for exactly the same number of sales as specialties (9.2%).

<sup>66</sup> '50 Jahre Knoll A.-G., Ludwigshafen', in: *Pharmazeutische Zeitung*, 07.03.1936, p. 275.

<sup>67</sup> A. Knoll from 1881-1885. Schulz-Thomas, *100 Jahre*, p.18.

Overadentriferrin (1900) and Bromural (1906).<sup>68</sup> Specialties accounted in 1916 for about 75% of overall sales, whereas alkaloids accounted for the remaining 25%.<sup>69</sup>

Least among former drug wholesalers was Vereinigte Chininfabriken Zimmer & Co, GmbH, Frankfurt a. M. (*Zimmer*): The company resulted from a merger in 1887 of the quinine companies Friedr. Jobst, Feuerbach, and Conrad Zimmer, Frankfurt a. M.<sup>70</sup> Specialities were e.g. Euchinin (1896), Validol (1897), Eunatrol (1897) and Optochin (1913).<sup>71</sup> *Zimmer* had an extraordinary export dependency because 90% of *Zimmer's* sales were generated outside of Germany.<sup>72</sup>

*Former dye producers:* Biggest among former dye producers and second largest German pharmaceutical manufacturer was Farbenfabriken vorm. Friedr. Bayer & Co. AG, Elberfeld near Düsseldorf (*Bayer*). *Bayer* was founded in 1863 by the dye trader Friedrich Bayer and the dyer Friedrich Weskott to start the production of magenta. In 1884 Bayer's posterior CEO (1912), Carl Duisberg, officially entered the service of the company. He proposed to experiment with pharmaceuticals, which led to the discovery of Phenacetin in 1887.<sup>73</sup> Bayer's long term blockbuster was Aspirin (acetylsalicylic acid), widely marketed from 1899 on.<sup>74</sup> In 1913 pharmaceuticals accounted for 18.9% of total sales.

The Elberfeld firm was closely followed by Farbwerke vorm. Meister, Lucius & Brüning AG, Höchst a. M. near Frankfurt (*Hoechst*). The company was founded in 1863 to produce aniline dyes by the merchant Carl. F. W. Meister and the chemists Eugen Lucius and Adolf Brüning.<sup>75</sup> *Hoechst* marketed its first pharmaceutical Kairin three years later.<sup>76</sup> Blockbusters were Antipyrin (1884) and Pyramidon (1897). *Hoechst's*

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<sup>68</sup> For market entry of Knoll's pharmaceuticals: Knoll's Mitteilungen für Ärzte, Jubiläumsausgabe 1886-1936., p. 11. AKA, ZA 34.

<sup>69</sup> Most important products that year were Tannalbin (24.9% of total sales), Bromural (19.4%), Digipuratum (18.9%) and Diuretin (8%). IG Jahresbericht für 1917. MA R15/14e; Anlage No. 7 zum Jahresbericht per 1917. EMA R15/14 e; In 1908 the ranking was: 1. Diuretin, 2. Tannalbin, 3. Santyl, 4. Bromural, 5. Styptol. Quantities: Statistik der Specialpräparate Verkäufe & Kosten länderweise 1898 bis 1909. AKA FA 030; Prices: Verzeichnis der Specialpräparate nebst Alkaloidmarken, AKA J 006. Cf. Anonymous, 'Geschäftliches'.

<sup>70</sup> Ziegler, *Familie Jobst*, p.128ff; This company is not to be confused with a company of G. C. Zimmer in Mannheim that produced salicylic acid. Wenzel, *Adressbuch*, Vol.5 (1896), p. 404. Cf. Contract 17.12.1893, SWA U 107 Sign. 2819.

<sup>71</sup> Spezial-Präparate Zimmer, in: *Denkschrift der C. F. Boehringer & Soehne*, p. 46f. Zimmer's mainly sold product was quinine. But especially Euchinin and Validol repeatedly generated big parts of the net profits due to a high price volatility in the raw china-bark. Protokollbuch, EMA H1/157.

<sup>72</sup> Protokollbuch, p. 362ff. EMA H1/157. This provoked an existential crisis when World War I started. Even Merck was surprised by Zimmer's export dependency.

<sup>73</sup> Farbenfabriken Bayer, *Geschichte*, p. 624.

<sup>74</sup> Wimmer, *Wir haben immer was Neues*, p. 265, 317. Aspirin was still Bayer's the most selling product in the 1920s and beginning 930s.

<sup>75</sup> *Farbwerke 1863 – 1913*, Pinnow, *Zur Erinnerung*; Wimmer, *Wir haben*, p.150.

<sup>76</sup> Wimmer, 'Tradition und Transformation', p. 182.

biggest seller was the chemotherapeutic Salvarsan (1910) and its derivatives, such as Neosalvarsan (1912). In 1913 pharmaceuticals accounted for 14.2% of total sales.<sup>77</sup>

Third among former dye producers in pharmaceuticals in 1913 was Actiengesellschaft für Anilinfabrikation AG, Berlin (*AGFA*). The company was founded as a joint stock company in 1873 by the chemists Paul Mendelssohn Bartholdy and Dr. C. A. Martius to produce aniline dyes and intermediates. *AGFA* started a pharmaceutical production (Phenacetin) in 1892.<sup>78</sup> Its first speciality was Chloroform-Anschütz (1894).<sup>79</sup> In 1913 its most selling drug was Acidol-Pepsin (1905).<sup>80</sup> Nevertheless pharmaceutical sales only counted for a little more than 1% of *AGFA's* total sales in 1913 (Fig. 1).

The smallest company in pharmaceuticals in this group was Kalle & Co. AG, Biebrich a. Rh. near Frankfurt (*Kalle*). It was founded in 1863 by the chemist Dr. Wilhelm Kalle and the merchant Jacob Alexander Kalle (his father) to produce aniline dyes. *Kalle* was a first mover in pharmaceuticals producing Jodol (1885) and Antifebrin (1886) but could not defend its first mover advantage. In 1908 *Hoechst* and *Cassella* together took over 88.8% of *Kalle's* total joint stock. Whereas pharmaceuticals had accounted for 13.6% of sales in 1891 this number fell to 3.7% in 1913.

Taking into account the dynamic evolution of the pharmaceutical business during the German Empire it can be shown that the former dye producing companies followed different paths of learning. Figure 1 contrasts the decline of importance of the drug business at *Kalle* with the continuous importance of pharmaceuticals at *Bayer*. This might be a sign of *Kalle's* inability to market new blockbusters once it was discovered that Antifebrin had more toxic effects than Phenacetin. Although no continuous data is available for *Hoechst* during the 1890's it is reasonable to attribute a high importance to its pharmaceutical business at the beginning of the decade which only recovered about 20 years later with the introduction of Salvarsan.<sup>81</sup> For *AGFA* pharmaceuticals never reached an important height in relation to total sales.

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<sup>77</sup> Salvarsan alone made 6.3% of sales. But total sales numbers for 1913 differ. According to another source the value is a little less (12.8%) with Salvarsan generating 5.7% of overall sales. HoechstA RFL 28 Werk Hoechst 1906-1924, Umsatz u. Verkaufsstatistiken versch. Jahrgänge, 6/.

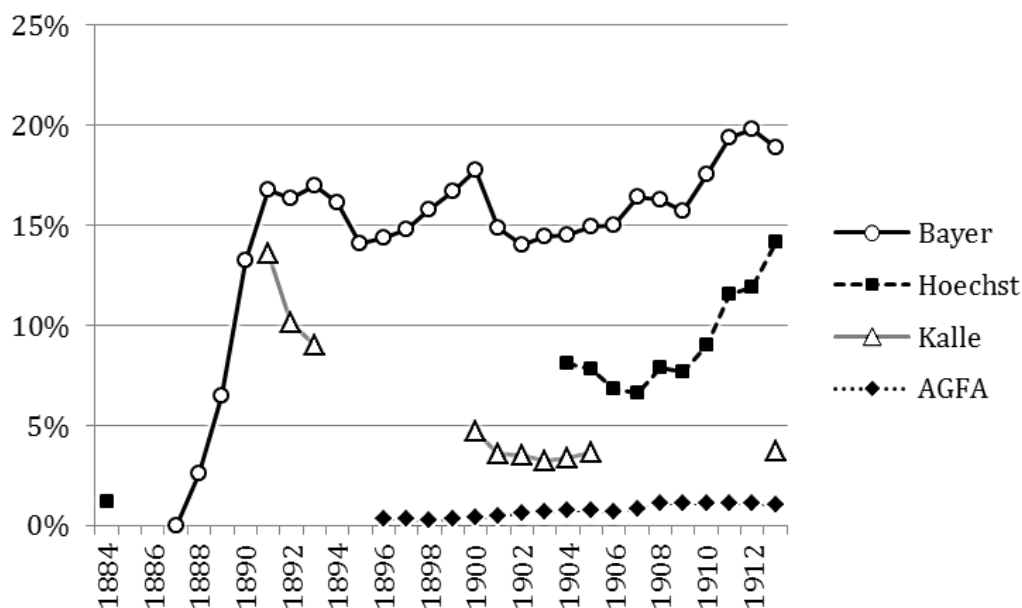
<sup>78</sup> Bericht der Methyfabrik über die Fabrikation in den Monaten Juli, August, September 1892, BArch R8128-16210. In 1894 it also produced Antifebrin and Dermatol, cf. Jahresbericht über die Fabrikation in der Methyfabrik im Jahre 1894, BArch R8128-16212; Beiträge zur Geschichte, p. 9, BAL 5/E.44.

<sup>79</sup> Jahresbericht des Versuchslabors für das Jahr 1893, BAL 5/E.A.26. In 1896 *AGFA* already sold 869Kg of Chloroform Anschütz. Jahresbericht 1897, BArch R8128-15757. For *AGFA's* pharmaceuticals see Vershofen, *Wirtschaftsgeschichte der chemisch-pharmazeutischen Industrie*, Vol. 3, p. 90-91.

<sup>80</sup> Jahresbericht 1906, p. 110, BArchB R8128-15763; Jahresbericht 1913, p. 104, BAL 5/E.A.24. For *AGFA's* early history see Willstädter, 'Zur Geschichte der Agfa'.

<sup>81</sup> In 1890 *Hoechst's* most important pharmaceutical was Antipyrin. That year 44 tons were sold at an estimated average price of 105 M/Kg. Antipyrin sales would thus count for 24.3% of *Hoechst's* overall sales. Wimmer, *Wir haben*, p. 154; Schreier/Wex, *Chronik*, p. 46; Anonymous, 'Frankfurt a. M.'.

Figure 1: Pharmaceutical sales to overall sales for former dye firms 1884-1913<sup>82</sup>



How does this picture fit into the international context of big dye corporations? Again a look at the second group of ‘path definers’ seems enlightening: At *Ciba*, the biggest Swiss competitor which produced both product groups, pharmaceutical sales reached a share of nearly 20% of overall sales in 1911/1912, a slightly higher share than that of its biggest German rival *Bayer*.<sup>83</sup>

Thus, the research, development and sale of pharmaceuticals had obtained a high importance also for the big corporations among dye producing firms (*Bayer*, *Hoechst*, *Ciba*). But what about the importance of dyes for traditional pharmaceutical corporations? As mentioned in the annexed business historical part *Heyden* tried to enter the dye market once a new product was available that promised high sales: synthetic indigo.

“Kalle % Co. in Biebrich is now also active in pharmaceuticals on a bigger scale, so it will not cause a big wondering if we finally start marketing dyes, as much as it is convenient for us.”<sup>84</sup>

Although big scale marketing of the dye only started in 1913 it had reached approximately 5.6% of total sales.<sup>85</sup>

Two exceptional ways were taken by *Boehringer Ingelheim* (I) and *Heyden*. The first started with the same ancestors as *Boehringer Mannheim* but it accumulated profits by

<sup>82</sup> For sources see appendix.

<sup>83</sup> Straumann, ‘Farbstoffe gegen Rohstoffe’, p.291. Ciba’s sales that year included furthermore 15.3 CHF million (dyes) and 1.8 CHF million (chemicals) totalling 20.9 CHF million (= 16.72 M million).

<sup>84</sup> Letter F.v.H. to Chemische Fabrik von Heyden AG, 18.08.1903. SWA U 107 Sign. 30.

<sup>85</sup> See the business historical part in the appendix for details.



selling lactic acid first and only then started a large production of alkaloids within a very short time. *Heyden* came from an academic background but large scale production was majorly financed by a dye wholesaler/industrialist.<sup>86</sup>

To understand the dynamics of market structural change, Table 2 summarizes the points-of-entry (POE) into pharmaceuticals of all companies by their abbreviations (Abr.) and lists their foundation dates (F).

*Table 2: Points-of-entry (POE) into pharmaceuticals and foundation dates (F) 1827-1918<sup>87</sup>*

Abr.	MER	RIE	ZIM	TROM	SCHE	BOE M*	GEH	HEY	HOE	BASF	KAL	KNO	BAY	AGFA	BOE I	CAS
POE	1827	1827	1837	1842	1855	1859	1866	1874	1883	1885	1886	1886	1887	1892	1905	1918
F	1668	1814	1837	1837	1851	1859	1835	1874	1863	1865	1863	1886	1863	1873	1885	1870

\* until 1872 in Stuttgart

It is obvious that the highest entrance frequency prevailed in the 1880s and beginning 1890s. More than a third of all companies (6/16) entered in the “long 1880s”. Most of these new entrants (5/6) belong to the above mentioned third group of firms: The traditional dye companies. It has been stated that these enterprises had an incentive to diversify into pharmaceuticals because they intended to exploit synergy effects between dye and pharmaceutical research.<sup>88</sup> They could also have done so to exploit the productive capacities they had obtained in dye production.<sup>89</sup> A third possible reason for their market entry into pharmaceuticals was that both groups shared a few common raw materials and intermediates.<sup>90</sup> Forth, obligatory public health insurance for workers was established in 1883 and it quickly increased its expenditures for pharmaceuticals.<sup>91</sup> So far, another fact has been widely ignored: Due to an immense rise in productive capacities and scale effects, prices for dyes constantly fell. Gustav Siegle, chief sales executive for *BASF* until 1889, spoke of a “demoralization in the dye market”<sup>92</sup>. The industry tried to stop falling prices and thus falling sales and profits by establishing cartels.<sup>93</sup> One of the biggest cartels or ‘conventions’, the Alizarin convention, broke up in

<sup>86</sup> For further details on both companies, e.g. on the industrialist (G. Siegle), see annex.

<sup>87</sup> For sources see appendix.

<sup>88</sup> Wetzel, *Naturwissenschaften*, p. 69; Reinhardt (‘Alizarinblau’, p.276) rejects this interpretation for BASF.

<sup>89</sup> Wimmer, *Wir haben*, p.153; Merck, *Entwicklung*, p. 9.

<sup>90</sup> Merck, *Entwicklung*, p. 8; Wimmer, *Wir haben*, p. 113; Redlich, *Bedeutung*, p.57. Some dye intermediates had medical properties and only needed to be produced in a pure quality to be applied as pharmaceuticals.

<sup>91</sup> For the expenses of the German Imperial health insurance from 1885-1914 see Landgraf-Brunner, *Auseinandersetzungen*, p. 86.

<sup>92</sup> Abelshausen, *BASF*, p. 54.

<sup>93</sup> The price for Alizarin fell from 18 M/Kg. (1873) to 4.8 M/Kg (1880). *Farbenfabriken Bayer, Geschichte*, p. 293. Cf. Pohl, *Chemische Industrie*, p. 107.

1884/1885 and prices quickly fell.<sup>94</sup> *Bayer* for example produced only very few other profitable products so that confidence in the survival of the firm diminished.<sup>95</sup> If market conditions for the main products increasingly worsened, it seems reasonable to argue that companies especially in times of corporate crisis searched for profitable alternatives.<sup>96</sup> If pharmaceuticals are a lucrative product segment and most of the big dye producing firms start diversifying into that field, why does one company step out a few years after its market entry? BASF's point-of-entry (POE) into pharmaceuticals was in 1885 (Tab. 2) and its point-of-exit in 1894 —why? It seems to have its explanation mostly in internal reorganization processes of management.<sup>97</sup> The new board made investments in a rentable indigo-synthesis its prime corporate strategy.<sup>98</sup> *BASF* was nevertheless anxious to (re-)enter the field of pharmaceuticals according to *Bayer's* top manager Carl Duisberg until in 1904 an agreement was signed between the two companies that made *Bayer* give up its indigo production in exchange for a non-activity in pharmaceuticals of *BASF*.<sup>99</sup> A reason for a positive valuation of the new product category can be seen in the pricing policy of pharmaceuticals. According to *Bayer* prices were more stable in pharmaceuticals but were they really more profitable than dyes?

“Pricing policy for the sale of pharmaceutical products differs essentially from that of the dye department, which has to reckon with very often changing prices. The trademark or patent protected, monopolized pharmaceutical products allow nearly in all cases a preservation of the price, the product was originally marketed at.”<sup>100</sup>

### III. Profitability of product portfolios in German big pharmaceutical business

Comparing the sales to profit ratio of dyes and pharmaceuticals in the early years after POE into pharmaceuticals (Table 3) confirms the picture of a saviour role of the medicines for dyestuff companies. Only scattered information is available on

<sup>94</sup> In 1900 a second ‘Alizarinkonvention’ was formed. Abelshauser, *BASF*, p. 72, 95.

<sup>95</sup> Farbenfabriken Bayer, *Geschichte*, p. 353

<sup>96</sup> According to J. Liebenau, ‘Ethical Business’, p. 117f, the dye producers resolved the 1885 crisis not only with new dyestuffs but also by opening up the new field of synthetic medicines.

<sup>97</sup> Reinhardt/Travis, *Heinrich Caro*, p. 235, 249. See also annexed business historical part. According to Abelshauser, *BASF*, p. 47, 93, the year 1889 is a caesura in BASF's history. The manager Siegle who was strongly interested in pharmaceuticals retreated from the commercial guidance of the company - the ‘era Siegle’ ended. Siegle was still associated with Heyden. Cf. Reinhardt, ‘Vom Alizarinblau zum Thallin’ p.272.

<sup>98</sup> Abelshauser, *BASF*, p. 47; Engel, ‘Produktionssysteme’, p. 84f. There also seems to have been little demand for the product by the mid 1890's. Even Merck could not sell large quantities after purchasing the Thallin patents and reducing production costs (from 85 M/Kg to 70 M/Kg). The patent voided in 1896. Jahresbericht 1896/1897 EMA F3-1b, 091-120; Jahresbericht 1897/1898 EMA F3-2b, 031-060.

<sup>99</sup> *Dokumente aus Hoechster Archiven*, Vol. 9, p. 16. Beer, *Emergence*, p. 122.

<sup>100</sup> F. Hoffmann, ‘Die pharmazeutische Verkaufsabteilung’ (Farbenfabriken Bayer, *Geschichte*), p. 441 (my translation).

pharmaceutical sales/profits during the 1880's and 1890's, so that the earliest available numbers are given here.<sup>101</sup>

*Table 3: Profitability of dyes and pharmaceuticals in M million 1884 and 1896*

Year	Hoechst		Bayer	
	1884		1896	
Product	Dyes	Pharma	Dyes	Pharma
Sales	11,379	0,135	22,335	3,884
Gross (g) profit	1,048	0,030	6,196	1,980
Net (n) profit	-	-	3,403	1,377
Profit (g) / sales	9,2%	22,5%	27,7%	51,0%

Both traditionally dye producing companies show a higher profitability in their pharmaceutical than in their dye product segment. The picture remains the same looking at net profitability even over a longer period in time.<sup>102</sup> The difference between gross and net profits mostly consists of the deduction of inventors' royalties. Only that amount of profit which at the end —after all deductions for raw materials, marketing expenses and royalties— remains with the manufacturer, represents his net profits.<sup>103</sup> These net profits of all product categories were finally taken to finance amortizations, funds for workers etc. Carl Duisberg, head of *Bayer's* research facilities from 1886 and later general director (CEO), explained his interest in pharmaceuticals in 1889 explicitly with a higher profitability of this department:

“That is all I can report on your favourite field, the pharmaceuticals, in which I am myself extraordinarily interested since I have seen that the production of pharmaceuticals is designed more to provide profits than it is the case in the dye works.”<sup>104</sup>

Pharmaceuticals had gained a big importance even for dye companies – especially before the introduction of synthetic indigo.<sup>105</sup> Pharmaceuticals were even ahead in terms of

<sup>101</sup> Unfortunately no common base year can be given as Hoechst's only existing number in the 19<sup>th</sup> century is for 1884. Bayer's numbers start in 1896.

<sup>102</sup> A net profitability for Hoechst in 1884 may only be estimated for Antipyrin. Deducting an inventors royalty of 10% (Wimmer, *Wir haben*, p. 161) generates a net profitability of 12.3%. Net profitability for Bayer in 1896 was: 15.2% (dyes) vs. 35.4% (pharmaceuticals) compared to an average for the years 1896-1904 of 17.4% (dyes) vs. 32.9% (pharmaceuticals).

<sup>103</sup> Although book keeping was not yet standardized throughout all companies, gross profits were mostly calculated by deducting production costs (raw materials), packaging, freights/customs and agency commissions from sales. Further deductions of inventors' royalties and propaganda delivered net profits

<sup>104</sup> My translation. Original: “Das ist es was ich Ihnen über Ihr Lieblingsgebiet die pharmaceutischen Producte, für welche ich mich selbst ausserordentlich interessiere, nachdem ich gesehen, dass die Fabrication zur Herstellung pharmaceutischer Producte mehr zu Verdienst angelegt ist, als dies bei den Farbenfabriken [sic] der Fall, berichten kann”. Letter Duisberg to Böttinger, 14.02.1889, p.4. BAL 271/2 Bd. 1. Cf. Rinsema, *natuur*, p.171.

<sup>105</sup> Indigo quickly gained high sales volumes: Its share of total sales was for a) BASF: 2% (1897), 28.8% (1904), 29% (1913) and b) Hoechst: 23% (1905), 33% (1913) and c) Ciba: 8% (1911/1912). 1889-1904, III. Periode, Umsätze und Verteilung derselben auf die einzelnen Produkte. UA BASF T 001. Reinhardt, *Forschung*, p. 142; Straumann, ‘Farbstoffe gegen Rohstoffe’, p.291. Jahresbericht. 1905 HoeA 2/001 3, Höchster Umsatzstatistik (1913) HoeA 6/.

profitability at the beginning of marketing of synthetic indigo.<sup>106</sup> The margin was also significantly lower in non-self-manufactured wholesale goods, a reason why former drug wholesalers entered into pharmaceutical production.<sup>107</sup>

“These [wholesale goods, TC] step back very, very much behind our own products. As completely wrong and a total misjudgement of the situation shall it be declared, if the opinion emerged that the best would be to buy everything and close down the plant. This is occasionally expressed in displeasure, but has no ground.”<sup>108</sup>

Although no detailed profitability accounts survived for specific wholesale products, a confirmation for the assumption that wholesaling in general was less profitable than a production of specialities can be found in a statement of *Gehe*, the biggest drug wholesaler among all German pharmaceutical companies:

“Though Dresden’s sales have constantly increased, costs have still risen more; furthermore the fact that its base of profitable specialities so far only exists on a small scale and that the wholesaling in drugs and chemicals requires a large apparatus and yields little (...) Long ago we have come to the conclusion that Dresden’s salvation can only lie in an increase of its fabricating activities.”<sup>109</sup>

Merck concluded that *Gehe* had a bad profitability because it could not earn its high costs with either the drug or the unprofitable pharmacy business. Its fabricating and speciality business was too insignificant to support the “crushing” burden of costs.<sup>110</sup> A comparison in overall profitability of wholesaling and production is impossible due to missing data before 1906. Nevertheless a comparison of overall profitability of a single company which was mostly (*Gehe*), with one that was partly (*Merck*) and another one that wasn’t involved at all in wholesaling (*Knoll*), promises interesting insights.<sup>111</sup>

*Table 4 Profitability of wholesaling and production in M million 1906<sup>112</sup>*

1906	Knoll	Merck	Gehe
Sales	2,707	12,609	8,950
Net profit	0,464	1,364	0,436
Net Profit / sales	17,1%	10,8%	4,9%

<sup>106</sup> Travis, Rainbow, p. 223; Geigy failed to produce indigo due to unprofitable production processes. Ciba also struggled with profitability and finally generated a net profit/sales ratio of only 7% in 1913/14 in indigo. Klotzsche, ‘Indigo’, p. 22.

<sup>107</sup> At Merck in 1899-1900 the six mainly sold wholesale products only generated a gross profit/sales ratio of 15%. Jahresbericht 1899-1900, p.10. EMA F3/4a.

<sup>108</sup> My translation. Jahresbericht 1899-1900, p.10. EMA F3/4a.

<sup>109</sup> My translation. Pharmazeutische Spezialitäten “Gehe”, 11.11.1911. EMA H5/30.

<sup>110</sup> Spezialitäten – Betrieb Dresden, 06.11.1911, p.2. EMA H5/30. During the war (1916) the overall net profit/sales ratio had risen to 19.1%. 1917 Dresden. EMA R15/14b.

<sup>111</sup> Some scarce data for 1903 survived: Merck has a net profit/sales ratio of 8.7% compared to *Gehe* with 4.5%. Riedel had a comparabile wholesaling to Merck and also showed a comparabile overall profitability for 1906/07 of 10.2%. Protokollbuch, p. 33, HCAS P3; Bericht Conzen, p. 57. EMA F6/7

<sup>112</sup> For sources see appendix.

Table 4 indicates a possible relationship: The smaller the wholesaling activities the more profitable the pharmaceutical business. On average the profitability of wholesaling in Germany was 5-6% before 1906.<sup>113</sup> This amount fell to 3-4% until the outbreak of World War I due to the appearance of a new and mighty competitor.<sup>114</sup> The *Handelsgesellschaft deutscher Apotheker (Hageda)*, a retailer cooperative of German pharmacists, was founded in April 1904 in Berlin and quickly expanded its sales.<sup>115</sup> It maintained normal wholesale prices but distributed its profits among members.<sup>116</sup> The *Hageda* was underestimated by the pharmaceutical industry at the beginning but quickly rose up to be among the biggest wholesalers in Germany by the outbreak of World War I.<sup>117</sup> Traditional drug wholesalers felt endangered by the *Hageda*, mostly in specialities.<sup>118</sup> Wholesalers first lobbied against the *Hageda* and then established an own retailing cooperative in Frankfurt, the *Grosseinkauf für Medizinalwaaren GmbH (Mediwa)*, by the end of 1907.<sup>119</sup>

Nevertheless there were big differences in the net profit/sales ratio among different pharmaceutical product categories: There were those products protected by patents and trademarks, called “specialities” and other products such as alkaloids without any intellectual property protection.<sup>120</sup> It is interesting to see in Tab. 5 that former pharmacies showed a constant but relatively low share of specialities from 1908-1913 whereas dye companies seemed to have concentrated nearly exclusively on this product

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<sup>113</sup> Rosenberg, *Vertrieb*, p. 70.

<sup>114</sup> *Ibid.*, p. 71; It fell to 2-3 % in 1927. Winkelmann, *Arzneispezialitäten*, p. 54.

<sup>115</sup> Wüllrich, *Geschichte*, p. 55, 67f, 124. The precursor of Hageda, the *Einkaufsvereinigung der Apotheker Berlins m.b.H.*, was founded in December 1902. Its sales remained comparatively low until it was restructured and nationwide sales started in October 1904. Sales rose from 0.5 M million (1904) to 2.3 M million (1905) and 24.1 M million (1913). Balances and sales were published annually in *Apotheker-Zeitung*. Cf. e.g. Anonymous, ‘Handelsgesellschaft’, p. 170; Anonymous, ‘Salzmann’, p.31.

<sup>116</sup> Therefore Hageda’s average net profitability from 1905-1912 (6.1%) confirms the low profitability of wholesaling. Rosenberg, *Vertrieb*, p. 71.

<sup>117</sup> A mutual dependence existed especially for the Hageda and the member firms of IG Pharma (for IG Pharma see “evolution of cooperation” below). IG Pharma’s products made 3.7% (1905), 4.3% (1913) and 5.2% (1915) of Hageda’s total sales. Umsatz der I.G. mit der Hageda, 1905-1913, EMA H1/153; Letter Merck to IG Pharma, 13.10.1916, AKA FA 083.

<sup>118</sup> In 1909 twenty-five big speciality wholesalers existed in Germany. It was estimated that these wholesalers lost approximately 10-15 M million to the Hageda in 1912. Rosenberg, *Vertrieb*, p. 41, 70.

<sup>119</sup> Riedel and Gehe joined Mediwa in 1912 but it could not generate significant profits until 1913. Jahresbericht 1911 and 1912, Abt. D I, EMA F3-15a, F3-16a; Rosenberg, *Vertrieb*, p. 73f; Daum, *Lagerhaltung*, p. 89; Anonymous, ‘Fragen’, p. 711f; Wüllrich, *Hageda*, p. 144ff; Salzmann, ‘Entstehungsgeschichte’, p. 1081; Letter Riedel to IG Pharma, 04.12.1916, AKA FA 083; Wenzel, *Adressbuch*, Vol. 12 (1912), part III, p. 39.

<sup>120</sup> One third of all specialities sold in Germany in 1915 to pharmacies were supplied by Hageda. An increasing demand for specialities can be seen in the share of specialities in total sales of pharmacies and wholesalers. Although only fragmentary data is available the increase is obvious: In urban South-German pharmacies the shares were (in %): 13 (1897), 16 (1901), 23 (1908), 51 (1915) and up to 75 (1926). The share at wholesalers were: 20-30 (1900) and 80 (1926/27). Letter Boehringer, 03.10.1916, p.15; Letter Merck to IG Pharma, 13.10.1916, both AKA FA 083; Wüllrich, *Geschichte*, p. 16; Winkelmann, *Arzneispezialitäten*, p. 53, 81; Cf. Adlung/Urđang, *Grundriß*, p. 176f; Wimmer, *Wir haben*, p.46.

category.<sup>121</sup> Most dynamic among pharmaceutical manufacturers were the former drug wholesalers. These firms nearly reached to double their share of specialities in total sales from 1908 until 1913.

*Table 5: Share of specialities in total pharmaceutical sales 1908-1913 (in %)<sup>122</sup>*

<b>Company/year</b>	<b>1908</b>	<b>1909</b>	<b>1910</b>	<b>1911</b>	<b>1912</b>	<b>1913</b>	<b>∅</b>
<i>Former pharmacies</i>							
Merck	11	13	13	13	13	12	<b>13</b>
Riedel	17	19	19	19	19	19	<b>19</b>
Schering	-	-	-	-	-	16	<b>16</b>
<i>Former dye firms</i>							
AGFA	92	92	94	90	90	91	<b>91</b>
Hoechst	80	83	72	-	-	-	<b>78</b>
<i>Former drug wholesalers</i>							
Knoll	39	48	53	59	60	65	<b>54</b>
Boehringer M	8	11	11	13	16	15	<b>12</b>

Sometimes new production processes for specialities were patented by a competitor of the original speciality. A way to obtain or preserve quasi-monopoly returns then was the establishment of cartels ('conventions') among all the producers of a specific medicine. Contemporaries therefore often differentiated their manufactured goods in "cartel" (*Conventionspräparate*) and "patent and speciality" products (*Patent- und Spezialpräparate*). It seems reasonable to concentrate mostly on the latter group of products due to their higher profitability: The more specialities a company had in its pharmaceutical product portfolio the more profitable was its business. Cartelization was done to end price wars of non-patented or differently patented products.<sup>123</sup> This was in Germany e.g. the case for salicylates, alkaloids, Salol, Phenacetin, Piperazin, Sulfonal, Veronal and many more.<sup>124</sup> Mostly these cartels had a world-wide scope.

<sup>121</sup> Merck's profitability rose from after the introduction of its important speciality Veronal (1903). Cf. footnote 54.

<sup>122</sup> For sources see appendix.

<sup>123</sup> Heyden feared "that some plants (...) work unprofitably for a period of war which precedes an agreement among manufacturers" (my translation). Geschäftsbericht 1910, p.2. SWA U 107 Sign. 13.

<sup>124</sup> Cf. Merck Jahresberichte, Conventionen, different years. EMA F3-1a(1896/97)-17a (1913); Farbenfabriken, *Geschichte*, p. 441; Kretzschmar, *Kartellbewegung*, p. 155-157.

Figure 2: Net profitability of Merck's cartel and speciality products 1906-1914<sup>125</sup>

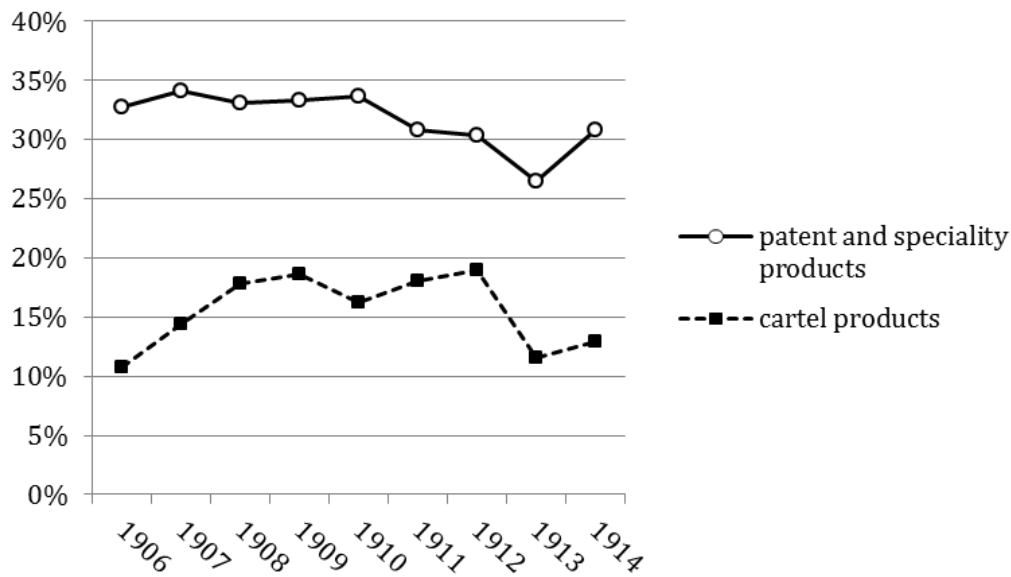


Figure 2 illustrates the ratios of net profits/sales for both groups of Merck's manufactured products. On average patent and speciality products showed a profitability of 31.7% whereas cartel products only generated a profitability of 15.5% from 1906 until 1914. Profitability was reduced in 1913 for patent and speciality products mostly due to higher advertisement costs and for cartel products due to decreased prices especially for cocaine, codeine and morphia.<sup>126</sup> The increased profitability of conventional products from 1906 can be explained with coming into force of the "I.G. Pharma" between *Merck*, *Knoll*, *Boehringer M* and *Gehe* in January 1906.<sup>127</sup> *Riedel* joined the four companies in April 1907. Thereby some conventions disappeared because the partners adopted *Merck's* pricing policy and limitations in quantities were redundant now due to the stipulated profits quotas.<sup>128</sup> A higher net profitability of patent and speciality products in comparison with cartelized products can also be observed at other companies and throughout time: In 1898 it was at *Bayer* 29% vs. 22.2% and at *Hoechst* 39.8% vs. 6.5% in 1910.<sup>129</sup>

<sup>125</sup> For source see appendix.

<sup>126</sup> Betrachtungen über das Ergebnis in Darmstadt 12.05.1914, in: IG Geschäfts-Bericht 1913 E. Merck EMA R15/14a.

<sup>127</sup> Cf. Burkert, *Die pharmazeutische Interessengemeinschaft* (and see below).

<sup>128</sup> Jahresbericht 1907, p.3. EMA F3-11a; Tätigkeitsbericht Conzen, p.54. EMA F6/7: "As we enforced upon our allies in the I.G. from the beginning our pricing policy, so couldn't it be missing, that Darmstadt's results showed rising profits after the elimination of these former competitors (...)" (my translation).

<sup>129</sup> For 1916 Knoll lists gross profitability of both groups: 55.7% vs. 47.4%. Knoll's cartel products were alkaloids. For Hoechst and Bayer products had to be grouped by the author. Specialities were detected according to the Freia-list (see below). If a speciality was produced by a different firm as mentioned in the list (Veronal/Hoechst, Piperazin/Bayer) it was counted as a cartel product for that firm. A Mixture of an own patented compound (Migränin) was counted as speciality.

#### IV. Evolution of firms, syndicates and cartels

Beyond the increasing production of pharmaceutical specialities, German pharmaceutical companies developed different non product-related strategies for the improvement of their profitability: a) reduction of marketing-related costs (publicity, agency royalties) and avoidance of price wars among manufacturers through pooling of profits (*Interessengemeinschaften*), b) bundling of resources for a fight on outsiders and opposed interest groups in and out of Germany through business associations (*Interessenverbände*).<sup>130</sup>

The first strategy was initiated by the *Bayer* manager Carl Duisberg in December 1903. He wanted a merger of big dye companies (*BASF, Hoechst, AGFA, Bayer*) but also send a memorandum to the pharmaceutical industry.<sup>131</sup> A unification of both industrial groups didn't happen but —although often omitted in literature— the “small” (1904) and “big IG” (1916), predecessors of IG Farben, also included pharmaceuticals.<sup>132</sup> The “small IG” composed of *BASF, AGFA* and *Bayer* (“Dreibund”) had different committees on pharmaceuticals.<sup>133</sup> The second block of a small IG in Germany was the “Zweibund” (1904) between *Hoechst* and *Cassella*.<sup>134</sup> Both companies participated with stakes in each other's equity.<sup>135</sup> They cooperated with an external scientist, Paul Ehrlich, and his Georg-Speyer Haus and marketed newly discovered pharmaceuticals uniquely through *Hoechst* until 1918 (see *Cassella*).<sup>136</sup> Duisberg's memorandum initiated market dynamics which led to the formation of another IG among pharmaceutical manufacturers (*IG Pharma*).<sup>137</sup> In 1904 *Knoll* and *Boehringer M* approached *Merck* with the idea to form a profit sharing agreement.<sup>138</sup> *Knoll* wanted *Gehe* to join the group of member companies. Because *Riedel* changed its legal form to a joint stock company the companies thought of buying shares at the beginning, but then decided to incorporate *Riedel* in the *IG Pharma* which became effective from the first of April 1907.<sup>139</sup> An existential problem for *IG*

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<sup>130</sup> In Germany the industry mostly struggles with pharmacists and the Imperial Health Office. Cf. Hickel, 'Kaiserliche Gesundheitsamt'. In foreign countries the industry had to deal with the non-existence of trademark protection, violation of trademarks, and selling of imitations.

<sup>131</sup> Waller, *Probleme*, p.81ff; Duisberg, 'Denkschrift'.

<sup>132</sup> Cf. Plumpe, *I.G. Farbenindustrie*, p. 78, 98; IG Verträge 10.12.1904;18.08.1916. BAL 5/E.A.59.

<sup>133</sup> Ausschüsse des Delegationsrates für besondere Angelegenheiten 1904. Mitglieder der Kommissionen 1916. BAL 5/E.A.59. They comprised scientific, technical and commercial aspects of pharmaceutical business.

<sup>134</sup> Vollmann, *Eigenständigkeit*, p. 167ff.

<sup>135</sup> 1907 Ciba tried to merge with Kalle which failed and resulted in an acquisition of nearly 90% of Kalle's stock by Hoechst/Cassella, forming the so called “Dreiverband”. Klotzsche, 'Indigo', p.16.

<sup>136</sup> Due to the success of Ehrlich with dyes as medicines, AGFA started to investigate this product category too. Jahresbericht AGFA 1907, p. 101. BArch R8128-15764.

<sup>137</sup> Burkert, *Die pharmazeutische Interessengemeinschaft*, p. 97.

<sup>138</sup> Bericht Conzen, p. 47. EMA F6/7. Cf. Previous deliberations EMA R15/16b.

<sup>139</sup> Protokoll Sitzung IG, 22.03.1905, EMA R 15/16b. Cf. IG Pharma contracts: 01.12.1906, AKA F A 110; 31.10.1907 EMA H5/43;



*Pharma* was the height and non-compliance with profit quotas which also provoked its final end in 1920.<sup>140</sup>

“[The] disturbance of peace in the I.G. caused by the bad results of Boehringer’s firm. These concern the inclination of Boehringer to leave the community. This case is not provided for in the I.G. contract and must be accepted unanimously.”<sup>141</sup>

For *Merck* the *IG Pharma* was especially beneficial.<sup>142</sup> An unarticulated aim of *Merck* was:

“That is also the aim that I am unremittingly pursuing: I want to prevail against these people, to hold them strongly in my hands and hence obtain a position so dominant in this industry, that none of the existing firms may compete with me in the long run.”<sup>143</sup>

The *IG Pharma* was transformed in 1920 into a South German pharmaceutical IG between *Merck*, *Boehringer M* and *Knoll*.<sup>144</sup>

Little is known about the bundling of resources for the fight against outsiders and opposing interest groups. For political lobbying in Germany, e.g. in favour of an amendment of the patent act in 1886, dye and pharmaceutical industry mostly relied on the influential “Verein zur Wahrung der Interessen der chemischen Industrie” (VzW), founded in 1877.<sup>145</sup> A bundling of resources exclusively for pharmaceutical interests was fostered after the turn of the century.<sup>146</sup> The first one was called “Vereinigung zur Bekämpfung von Auswüchsen im Inseratenwesen”(1905).<sup>147</sup> Its aim was to limit marketing expenditures of scientific publicity.<sup>148</sup> 1906 its name was changed to “Inserentenverband chemisch-pharmazeutischer Fabriken” and the companies

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<sup>140</sup> First problems arose in mid-1908. Boehringer M’s quota was a lot higher than its real profits. Merck negated to pay the difference, i.e. compensate Boehringer M, and demanded new quotas. Mannheim was about to leave IG Pharma. The difference was caused by high research expenses in Mannheim which were not counted as costs but as future profits (!). Bericht Conzen, p. 49ff. EMA F6/7. Finally Riedel and Gehe left in 1920 due to missing (confiscated) profits of Merck & Co.

<sup>141</sup> J.D. Riedel AG, Aufsichtsratsprotokolle 1905-1913, p. 64f. HCSA P3 (my translation).

<sup>142</sup> “(...)because the four firms must frequently maintain my prices and their competition is eliminated, at same prices I am just preferred due to my brand” (my translation). Letter to G. Merck, 15.07.1909, p.4. EMA H1/57.

<sup>143</sup> My translation. Letter E. Merck to G. Merck, 15.07.1909, p.6. EMA H1/57.

<sup>144</sup> Burkert, *Interessengemeinschaft*, p. 170: New quotas represent Merck’s dominance: 63% vs. 23.5% (Boe M) and 13.5% (Kno). The three companies had started already in 1915 to market jointly a cheap segment of tablets and ampoules under the name MBK (for Merck-Boehringer-Knoll). Cf. Bericht Conzen, p. 58, EMA F6/7; Schulz-Thomas, *100 Jahre*, p. 61f; Knoll AG Development and Products, p. 19f, AKA J 153; Therapeutisches Vademecum, Vol. 13, p.75ff, RDA no shelfmark.

<sup>145</sup> Seckelmann, *Industrialisierung*, p. 201f; Hickel, ‘Gesundheitsamt’; Cf. Wimmer, *Wir haben*, p. 33.

<sup>146</sup> On the Heidelberg meeting of the VzW, 22.09.1905, it was agreed to meet on 01.12.1905 to jointly resolve two issues of pharmaceutical industry; Speech Köbner, p.1, SchA B1-750/1.

<sup>147</sup> Bestimmungen der Vereinigung zur Bekämpfung von Auswüchsen im Inseratenwesen. BAL 170/2.1

<sup>148</sup> Cepha Protokollbuch, p.1f. BAL 170/2.2. A black list of newly established European medical journals to be avoided by members due to uncertain circulation numbers was issued.

intensified their exchange of information to foster trustworthiness of medical reports.<sup>149</sup> In 1908 the association received its final name “Verband der chemisch-pharmazeutischen Großindustrie e.V.” (*Cepha*).<sup>150</sup> *Cepha’s* biggest opponents in Germany were doctors, pharmacists and the Imperial health insurance system.<sup>151</sup>

The second big association was the “Zentralauskunftsstelle für Markenschutz” (*Zema*).<sup>152</sup> Its aim was to foster the interests of the manufacturers in trademark law and mutual information on such issues.<sup>153</sup> Especially pharmacists lobbied against trademark protection of pharmaceuticals.<sup>154</sup> Furthermore wholesale druggists often recommended substitutions for branded products in their price lists.<sup>155</sup> A big controversy arose on the discussion if pharmaceuticals should be exempted from trademark protection as it was done in Romanic countries.<sup>156</sup> As in 1909 a sales agent of a *Zema* member firm offered a product with the indication that it is chemically identical and pharmacologically equal, a special meeting of *Zema* members appointed a commission that was instructed to elaborate a draft agreement on specialities.<sup>157</sup>

“The intend to find a practicable way to such an association showed, that extraordinary difficulties exist and prompted us to oppose the regulation in the Zentralstelle, in which it doesn’t belong as such. We succeeded the elimination of further deliberations from the meetings of the Zentralstelle (...) Meanwhile we don’t believe that a satisfactory solution may be found.”<sup>158</sup>

This agreement, the “Freie Vereinigung zum gegenseitigen Schutze pharmazeutischer Originalpräparate”(Freia), was going to become the most important of the associations. The contract was signed in March 1910 among the biggest German and Swiss manufacturers of pharmaceuticals.<sup>159</sup> It assured a member company which possessed both patent and trademark protection for a product that it had marketed for the first time on an industrial scale before November 1909 the absolute and unique marketing rights for an unlimited time. This was especially important for products for which patent

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<sup>149</sup> MD’s who repeatedly offered their services for medical articles or often asked for free samples were banned just as editors who offered to deliver medical studies free of charge in exchange for inserts.

<sup>150</sup> On 19.09.1908 its name was changed and it was registered in Frankfurt. Cover sheet, BAL 170/2.1.

<sup>151</sup> The Deutsche Apotheker Verein (DAV), the Handelsgesellschaft deutscher Apotheker (HAGEDA), and the Federal Health insurance was stopped by Cepha in their manufacturing ambitions. Doctors published lists of pharmaceuticals to be avoided, Cepha intervened. Speech Köbner, SchA B1-750/1.

<sup>152</sup> *Zema’s* was registered in Frankfurt 1907 and its name changed to “Zentralstelle für Markenschutz e.V.” In 1924 *Zema* and *Cepha* were merged. Vershofen, *Wirtschaftsgeschichte*, Vol. 3, p. 134.

<sup>153</sup> *Zema*, Satzungen, 31.01.1908, §§2, 8 BAL 170/2.1, e.g. a list of appraised lawyers abroad was issued

<sup>154</sup> Wimmer, *Wir haben*, p. 92f.

<sup>155</sup> Even Gehe as a big drug wholesaler did this. Speech Köbner, p. 6, SchA B1-750/1.

<sup>156</sup> Rathenau, ‘Entwicklung’; Köbner, ‘Wortzeichenschutz’, Speech Köbner, p. 4, SchA B1-750/1.

<sup>157</sup> Merck as a big wholesaler was understandably reserved at first. Speech Köbner, p. 9, SchA B1-750/1

<sup>158</sup> My translation. *Zema*, in: Jahresbericht Pharmazeutika 1908, HoeA 2/001 (C/2/1/b).

<sup>159</sup> So far no detailed study exists on the Freia. Cf. Wimmer, *Wir haben*, p.101; Fleischer, *Patentgesetzgebung*, p. 338f; Lill, *Die pharmazeutisch-industrielle Werbung*, p.359ff; Vershofen, *Wirtschaftsgeschichte*, p.140f.

protection was about to expire. If a member company found a new process for a competitor's product, it obliged itself to form a cartel with the original producer.<sup>160</sup> Wimmer (1994, p. 101) therefore calls the *Freia* an "innovation cartel". The contract included the establishment of a list of original products. Due to conflicts about the inclusion of certain products, the list had been established during 1911 and the first 202 entries of the list are dated 1911/1912.<sup>161</sup> *Freia* can be thus seen as an attempt to prevent competitors of entering into ones products segments. That way price wars before the establishment of a cartel could be avoided. The German and the Swiss companies (*Roche, Ciba*) were members of all the three associations.<sup>162</sup>

"If our unification 25 years ago would not have yielded any other result than the *Freia*, it would have proven its right to exist. If we hadn't imposed upon us the wise self-limitation inherent in the *Freia* treaty, the waves of substitutions would have smashed up upon our most valuable products and we would have never been in the position to protect our original creations outwards so successfully as we did despite all of our oponents."<sup>163</sup>

The first *Freia* contract was signed in 1910, revised in 1912, and had duration until the end of 1914.<sup>164</sup> It was then revised and renewed in 1916, 1927 and 1931.<sup>165</sup> It protected specialities that had been introduced in Germany under a trademark against substitutions. Those generics that had been sold before and on the 11<sup>th</sup> November 1909 by another signing manufacturer as a substitution were permitted.<sup>166</sup> A list of protected products was elaborated, the so called *Freia* list.<sup>167</sup> Therefore the most important provision of the treaty was that those specialities for which patent protection was about to expire during the validity of the treaty would not be copied after the expiration by another signing company anywhere in the world. This was especially important for Hoechst and their expiring (1911) Pyramidon patent.<sup>168</sup> To judge the relative importance of high profitable products an essential question remains to be answered: Which German

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<sup>160</sup> Thus, the firms didn't market any imitations of the former original product.

<sup>161</sup> *Freia*-Liste. SchA 2/10; The contract was signed the 16.03.1910, conflicts arose on the issue if non-manufactured products by a drug wholesaler could be included and if a generic not sold as a substitution might still be sold even if the original is protected to another firm. In two meetings (18.11.1910, 24.01.1911) bot questions were positively answered. Geschäftsbericht der Zentralstelle für Markenschutz e.V. 1910. Hoechst Archiv Jahresberichte 1887-1924, 2/001 (alt: C/2/1/b).

<sup>162</sup> Zema, in: Jahresbericht Pharmazeutika 1909, p. 18. HoeA 2/001 (C/2/1/b). Nevertheless Ciba left Zema and *Freia* with the outbreak of World War I and only returned by 1927. Probably because both available *Freia*-lists were elaborated in the 1930's and 1940's no early Ciba specialties are included.

<sup>163</sup> My translation. Speech Köbner, p. 9, SchA B1-750/1.

<sup>164</sup> Signed 16.03.1910; *Freia*-Abkommen vom März 1910, neue Redaktion, 09.12.1912. BAL 367/292. The 1910 provisions are reprinted in: Jahresbericht Pharmazeutika 1909, Anlage II, HoeA 2/001.

<sup>165</sup> When Bayer in January 1915 wanted to have its speciality Ilun inscribed in the list discussions on the interpretation of the contract arose. A new one was signed in 1916 to be in force until 1919. Letter Hoechst to Zema/*Freia*, Neuanmeldung Ilun, 08.01.1915; *Freia*-Contract, 01.08.1916, both BAL 367/292

<sup>166</sup> Generics had a significantly lower price than the original. Cf. Schmitt, *Industrie*, p. 202f.

<sup>167</sup> Different issues of *Freia* lists can be found in SchA S1/006, 2/10. See also above (p. 20ff).

<sup>168</sup> Zema/Deutschland, in: Jahresbericht Pharmazeutika 1909, p. 18. HoeA 2/001 (C/2/1/b).

company had the biggest amount of original products in its portfolio. You can broadly confirm the picture drawn by Wimmer for the year 1911/12 using more comprehensive data for 1914.<sup>169</sup> Enlarging the time frame until 1914 reinforces Bayer's leading position in specialities (Tab. 6).

*Table 6: Corporate shares of total Freia products 1914*<sup>170</sup>

Company	Freia products	Share
Bayer	41	16,3%
Hoechst	31	12,4%
Knoll	22	8,8%
Merck	21	8,4%
Kalle	20	8,0%
Zimmer	20	8,0%
Heyden	19	7,6%
Schering	19	7,6%
Agfa	13	5,2%
Riedel	13	5,2%
Hoffmann-LaRoche	11	4,4%
Böhringer M	10	4,0%
Gehe	9	3,6%
Güstrow	2	0,8%
Total	251	100,0%

It is no surprise that dye companies with high pharmaceutical sales in relation to total sales (*Bayer, Hoechst*) also rank before corporations with a smaller share (Fig. 1). Interestingly the middle field (7-8%) is composed of six companies with very different product portfolios. Whereas *Heyden* sold mostly pharmaceutical products and indigo (from 1913), Schering also had a large photographic and camphor business. Nevertheless both companies had a similar share of total *Freia* “innovations” in 1914. Nevertheless the sole amount of supposedly high profitable products is an insufficient indicator if its importance for the total pharmaceutical sales remains unknown. For various firms exact speciality sales statistics (Tab. 5) facilitate an insight into the relative importance of specialities. It is therefore interesting to contrast the results of the last two tables. Whereas *Hoechst* and *Knoll* are among the leading companies in *Freia*-protected products, these specialities also have an extraordinarily big share of total pharmaceutical sales. Although at *AGFA* the pharmaceutical department was comparatively unimportant (Fig. 1) it was nearly exclusively composed of a few specialities. The data shows for *Merck* that despite a leading role in total *Freia*-protected products the overall importance of specialities was relatively low.<sup>171</sup> Therefore the company can be better considered as a big pharmacy than as a speciality producer.

<sup>169</sup> Wimmer, *Wir haben...*, p.228. Both lists (SchA S1/6 and 2/10) include 199 products for 1911/12 (Nr. 1-202, with 42-44 left out). plus 21 products inscribed until the end of 1912 (Nr. 203-224) and 9 products marketed no later than 1912 (numbers „0“) makes a total of 229 products for 1911/12.

<sup>170</sup> For sources see appendix.Cf. Wimmer, ‘Innovation’, p.284.

<sup>171</sup> It needs to be taken into account that Merck had a product portfolio of over 10.000 articles.

Although the existing literature suggests that only a few specialities produced most of pharmaceutical sales of German companies, this is only true for those companies with a high share of specialities in total sales.<sup>172</sup> For all other firms specific product sales should better be correlated with total speciality sales.

It is really important here to acknowledge that *Freia* was an international agreement which was signed from the beginning by Swiss companies. In Switzerland in 1907 a patent law that protected chemical inventions had been established. Thus, no Swiss imitation of German pharmaceuticals, as happened with Antipyrin, could now be marketed. *Freia* therefore worked as an international patent protection enlarger among the biggest companies.

## V. Evolution of science

Whereas maladies were treated until the end of the 1870's mostly with galenical preparations of vegetable origin, inorganic salts or alkaloids (from 1827 on), scientific developments in organic chemistry now allowed the synthesis from new raw materials.<sup>173</sup> The rise of the modern chemical industry after 1870 is generally explained by the incorporation of science, especially chemistry, into production.<sup>174</sup> Although the German dye industry profited from a wide availability of academically trained chemists, the key advantage of German chemical education at universities in general was a qualitative aspect: the obligation to do experimental laboratory work to obtain a PhD.<sup>175</sup> This kind of education prepared especially well to fit the demands of corporate research laboratories, where experimental work was daily routine. While profound scientific knowledge of chemists was a key advantage for dye companies, the necessities of pharmaceutical companies were somehow lower.<sup>176</sup> On the one hand production processes were relatively easier to copy in some product groups of pharmaceuticals and they were not so closely interconnected as in dye manufacturing.<sup>177</sup> On the other hand German manufacturers benefitted from the scientific evolution of physiology, clinical testing, physiologic

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<sup>172</sup> Wimmer, *Wir haben*, p. 120, 186, 317; Kobrak, *National Culture*, p. 364.

<sup>173</sup> Bernsmann, 'Arzneimittelforschung', p. 670 categorizes scientific publications according to the origin of the treated pharmaceutical substance (organic, inorganic etc.) from 1850-1900.

<sup>174</sup> According to Arora et al. ('Comparative Advantage', p. 248) what mostly differentiated the German chemical industry from foreign competitors was its willingness to invest in the commercialization of science-based innovations.

<sup>175</sup> Merck, *Entwicklung*, p. 40.

<sup>176</sup> *Ibid.*, p. 72.

<sup>177</sup> Whereas the German dye industry benefitted from a complex interconnection of different raw materials and intermediates, pharmaceutical products could be obtained from very different raw materials which didn't show any connection to other drug categories, e.g. iodine and cocaine.

chemistry, surgery, pharmacology and pharmaceuticals.<sup>178</sup> Hickel shows the primary research areas of German pharmaceutical firms and the resulting specialities from 1870-1905.<sup>179</sup> Most of these inventions resulted from a close cooperation of chemists, pharmacologists and physicians.<sup>180</sup> *Hoechst* named the possibility to gather results from an interdisciplinary research process in the beginning 1880's its prime incentive for their entry into pharmaceuticals in 1884.<sup>181</sup> According to the interdisciplinary model of academic research German and some foreign manufacturers like *Borroughs Wellcome* established a physiological laboratory next to the research laboratory to foster cooperation between chemists and pharmacologists.<sup>182</sup> An interdisciplinary pharmaceutical development spread from the Imperial university of Strasbourg to different German universities such as Erlangen, Munich, Freiburg, Berlin and Halle.<sup>183</sup> These scientists in turn cooperated with leading German manufacturers as *Hoechst*, *Bayer*, *Merck* or *Kalle*. Therefore the comparative advantages of German pharmaceutical firms lay only to a smaller extent in the exclusive availability of academically trained chemists but more in an evolving innovative research strategy of interdisciplinary scientific cooperation.

## VI. Evolution of institutions

The evolution of the pharmaceutical industry has been linked to the structure of national institutions from its inception.<sup>184</sup> Intellectual property protection was one of the most prominent institutions because they allow temporary monopoly profits in specialities. The German patent act of 1877 only protected processes. Due to Swiss competition, especially in dyes, the German Supreme Court declared in 1888 that the product which was produced by a protected process jointly enjoys protection.<sup>185</sup> Although the German patent acts (1877, 1891) formally forbade patenting of pharmaceuticals as a product in §1, in fact a pharmaceutical production process could be patented. A special decision of the German Supreme Court in 1890 on Antipyrin confirmed that by the protection of the

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<sup>178</sup> See Hickel, 'Grundlegung', p. 202 for prominent researchers of these areas at Strasbourg and their connections to pharmaceutical firms.

<sup>179</sup> Hickel, 'Arzneimittelforschung', p.136.

<sup>180</sup> Cf. footnote 148.

<sup>181</sup> This collaboration is said to have firstly facilitated the scientific application of pharmaceuticals. Letter Hoechst to Kaiserliche Gesundheitsamt, in: Hickel, 'Arzneimittelforschung', p.139

<sup>182</sup> Hickel, 'Grundlegung', p. 206.

<sup>183</sup> *Ibid.*, p. 211ff.

<sup>184</sup> Henderson et al., 'Industry', p. 276.

<sup>185</sup> The decision became famous as the so called 'Methylenblau-Urteil'. Seckelmann, *Industrialisierung*, p. 197ff.

process also the pharmaceutical product enjoyed protection.<sup>186</sup> In Switzerland no protection of whatsoever kind existed for chemicals until 1907 because invented processes could not be described in a model. And even after 1907, pharmaceutical production processes were exempted from patent protection in Switzerland.<sup>187</sup> This encouraged mutual “emigration” between German territories and the German speaking regions behind the Swiss border. On the one hand, *Knoll* and *Heyden* erected plants in Switzerland to produce products they were not allowed to in Germany, e.g. Antipyrin and Saccharine. On the other hand *Roche* and *Ciba* both erected plants in the 1890s in the German border town of Grenzach because there they enjoyed patent and trademark protection for pharmaceutical specialities.<sup>188</sup> In the USA and Great Britain pharmaceuticals could also be patented as products.<sup>189</sup>

German pharmaceutical producers increasingly concentrated on “patent and speciality” products. As already this name “patent AND speciality products” indicates not only patent legislation had an important impact on the marketing of pharmaceuticals. In this product segment trademark legislation was especially important.<sup>190</sup> Nevertheless trademark legislation, especially in an international perspective has often been neglected in business history.<sup>191</sup> Wilkins (1992) states that only trademarks (and not patents) helped the modern MNE to grow because these significantly reduced transaction costs, especially ex-ante information costs, on the consumers’ side.<sup>192</sup> This in turn stimulated demand for trademark protected products which made effects of scale and scope possible.<sup>193</sup> As an example Wilkins explicitly mentions a classical case for the importance of a trade mark: *Bayer’s Aspirin*.<sup>194</sup> Even in our days this acetylic salicylic acid product generates such high revenues that Bayer decided to buy its marketing rights on the US market back for 1 billion dollar in 1994.<sup>195</sup> Nevertheless if trademark regulation is mentioned at all in accounts on German chemical industry only the federal

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<sup>186</sup> Wimmer, *Wir haben...*, p. 86ff; Fleischer, *Patentgesetzgebung*, p. 140f.

<sup>187</sup> Stuber, *Patentierbarkeit*, p.28.

<sup>188</sup> Indeed nearly the whole production of Roche had moved to Grenzach until 1910. This turned out to provoke an existential crisis with the outbreak of World War I. Peyer, *Roche*, p. 49.

<sup>189</sup> Stuber, *Patentierbarkeit*, p.58; Four key differences between German and US patent laws in regard to pharmaceuticals are given in Burhop, ‘Pharmaceutical Research’, p. 484.

<sup>190</sup> Hickel, ‘Kaiserliche Gesundheitsamt’, p. 67 states that trademark protection was even more important to the pharmaceuticals industry than patents because often specialities could be produced by another process so that trademarks alone guaranteed individuality of the product.

<sup>191</sup> Duguid, ‘prejudice’; Duguid, ‘French Connections’; da Silva Lopes, *global brands*; Wilkins ‘Intangible Asset’.

<sup>192</sup> Wilkins, ‘Intangible Asset’, p. 81; Merck, *Entwicklung*, p. 63f highlights the extraordinary importance of trademarks and states that in contrast to patent which are uniquely destined to competitors, the trademarks are directed towards the “hundreds of thousands” of consumers of pharmaceuticals.

<sup>193</sup> Wilkins, ‘Intangible Asset’, p. 83, 88.

<sup>194</sup> *Ibid.*, p.78. She highlights that the German dye makers sought to use their German names in the US to take advantage of their international reputation (p. 90). McTavish, ‘Bayer’ focusses on a precursor.

<sup>195</sup> See footnote 19.

law of 1894 appears, as if there had not been protection of trademarks before.<sup>196</sup> Even contemporaries argued before the introduction of the 1894 law that trademark protection was especially important for pharmaceuticals:

“Of highest importance is the plant or trade mark for all those chemicals that shall find application for medical purposes and especially those contemporarily introduced artificial, i.e. synthetically produced pharmaceuticals. These tend to contain, even if one is very inclined to produce them chemically pure and to call them consequently “purissima”, more or less high rests of contamination, or even spoors of poisonous or corrosive substances, according to their origin and price-related trading quality, and which may vary in different marks and which may also escape the obligatory test of purity by the pharmacist. These different contaminations can make the use of a new pharmaceutical in the hands of doctors unsafe (...) and it has therefore become a habit, to pronounce also in the scientific literature related to new pharmaceuticals the origin [the producer, T.C.] and pay full attention to the brand while using.”<sup>197</sup>

Thus even before the law of 1894 in Germany trademark protection existed because producers mostly highlighted their plant mark (Firma) to indicate that the product has been manufactured by a trustworthy company. Even more, it is not true that no word marks, e.g. with phantasy names, had been used by the pharmaceutical Industry.<sup>198</sup> And from 1887-1894 it was even allowed for certain persons to register them in Germany.<sup>199</sup> This has its explanation in the fact that trademark law was highly transnational in nature, and in some cases was “international before it was national”<sup>200</sup>. A long tradition of trademark struggles took place all over Europe by the mid-19<sup>th</sup> century.<sup>201</sup> Still, internationally not everything was in order by the last decade of the 19<sup>th</sup> century.

Trademark laws in the 1870s forbade both in Great Britain and in Germany the protection of word marks (brands). Germany enacted a first federal trademark act in 1874. This German trademark law protected only labels and designs which were not allowed to be exclusively composed of words.<sup>202</sup> Therefore manufacturers massively circumvented this prohibition by adding small graphical items to the words.<sup>203</sup> Examples

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<sup>196</sup> Lill, *pharmazeutisch-industrielle Werbung*, p.79 dismisses the 1875 law because it didn't protect word marks, a statement which needs further explication as will be shown below.

<sup>197</sup> Wenzel, *Adressbuch*, Vol. 2 (1889/1890), p. 808.

<sup>198</sup> See the business historical part in this text for specialties introduced before 1894. Examples are Antipyrin, Phenacetin etc.

<sup>199</sup> Wenzel, *Adressbuch*, Vol. 2 (1889/1890), p. 811. Where trademark protection for words existed (e.g. GB and F) and where by law, treaty or convention trademark protection were also allowed to Germans, the same rights could be applied for in Germany. This means that foreigners had more rights to trademarks in Germany than Germans.

<sup>200</sup> Duguid, *French Connections*. In fact the Cobden-Chevalier treaty normally seen as the beginning of international free trade diffusion had its longest-lasting effect in trademark law .

<sup>201</sup> An interesting example is Farina, a producer of Eau de Cologne. Cf. Duguid, *French Connections*'

<sup>202</sup> Reuling, *Kritische Beiträge*, p. 322. The 1874 law is reprinted in English in Endemann, *Markenschutz*, p. 106.

<sup>203</sup> Kohler, *Recht des Markenschutzes*, p. 199. As words in any case were not allowed to express an indication of ingredients and as it was scientific habit in pharmaceuticals, phantasy names were created.



from the German pharmaceutical industry are *Riedel's* 1889 Thiol label, *Kalle's* 1890 Orexin label or *Bayer's* 1887 Phenacetin label.<sup>204</sup> The situation changed when the British Merchandise Marks Act in August 1887 protected also of foreign brands.<sup>205</sup> So far in most other European countries only national brands had enjoyed protection. It sanctioned imitation and unfair competition (concurrency deloyale) and enlarged the protection to trade descriptions (Waarenbezeichnungen).<sup>206</sup> At first the German chemical industry was very happy with the British act but a decision of the German Supreme Court in February 1888 confirmed that a brand could be assigned to a foreigner but not to a German citizen.<sup>207</sup> This provoked a lobbying movement among German chemical manufacturers because they feared serious disadvantages.<sup>208</sup> Finally a renewed German trademark law was elaborated in 1892 and enacted in 1894.<sup>209</sup> It also comprised brands used either on labels, price list, newspaper ads etc.<sup>210</sup> It was common sense that the new act “closed a gap” in permitting brands.<sup>211</sup> In a next step chemical manufacturers negotiated with the authorities on the principles of conferring word marks (brands).<sup>212</sup> Generally it was common practice to build pharmaceutical brands from a Greek root and add the suffix –in, -id, -al, -ol, -on and thus create phantasy names.<sup>213</sup> A good example of the difficulties of a German pharmaceutical firm with early brands from 1887-1894 is *Bayer's* brand Phenacetin. It also shows that *Bayer* was not an “old-time” pharmaceutical firm but an inexperienced newcomer.<sup>214</sup> *Bayer* first of all marketed the product in Germany under its scientific names Acetphenetidin or Quininphenid via the wholesale dealer *Gehe*.<sup>215</sup> The Dresden company in turn proposed a more catchy name: Phenacetin. From October 1887 *Bayer* protected its German labels

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<sup>204</sup> See reprints in Bernsmann, ‘Arzneimittelforschung’, p. 671.

<sup>205</sup> First legal changes in brands occurred in 1883 with the new patent law which also allowed labels only composed of words.

<sup>206</sup> For differences between the German law of 1874 and the British 1887 act see Anonymous, ‘Das britische Markenschutzgesetz’

<sup>207</sup> Anonymous, ‘Entscheidung’, Kohler, ‘Schutz gewerblicher Urheberrechte’, p. 804; Schmid, ‘Entwurf’, p. 378.

<sup>208</sup> Petition of the VzW to Imperial Government 1887 and 1888, in: Wadle, *Fabrikzeichenschutz*, Vol. 1, p. 262. In 1895 the VzW lobbied for a German participation in the Madrid Convention for trademarks. Cf. Die Chemische Industrie (1895), p. 24.

<sup>209</sup> Anonymous, ‘Entwurf eines Gesetzes’

<sup>210</sup> By the end of 1908 the German chemical industry was the second largest industrial applicant of trademarks in Germany. After the 1894 law the application of brands boomed. Cf. Bernsmann, ‘Arzneimittelforschung’, p. 671; Cf. Kohler, *Warenzeichenrecht*, p. 257; Wimmer, *Wir haben*, p. 93.

<sup>211</sup> Anonymous, ‘IV Warenzeichen’, p. 90. Brands were widely registered. Cf. Anonymous, ‘Denkschrift’, p. 150 which states that it was unavoidable to permit phantasy names due to international developments.

<sup>212</sup> Die Chemische Industrie (1896), p. 465. The registration of the brand had to be renewed each 10 years, cf. Kent, *Reichsgesetz*, p. 181.

<sup>213</sup> Anonymous, ‘Wortzeichen “Antipyrin”’, p. 15; Kent, *Reichsgesetz*, pp. 86, 100.

<sup>214</sup> McTavish, ‘Bayer’, p.

<sup>215</sup> Anonymous, ‘Zum Wortschutz “Phenacetin”’; Farbenfabriken Bayer, *Geschichte*, p. 409, 439.

carrying the name or if possible directly registered the brand as in the US.<sup>216</sup> As a result of the fact that *Bayer* could not get a patent on the production process of Phenacetin in Germany, the company tried to foster its brand rights.<sup>217</sup> To impede the alteration of its brand into a generic name, the company created marks composed of the brand itself and its individual plant mark. This made labels carry the denomination “Phenacetin-Bayer” from June 1888 on.<sup>218</sup> *Bayer* seems to have been quite sure about the validity of its brand rights at the beginning of 1889, but was surprised when competitors entered the market under the same brand by mid-1889.<sup>219</sup> *Bayer’s* board member Henry Böttinger called the first competitor, *Riedel*, “a god damn heavenly dog which barely has a right to exist”<sup>220</sup>. *Bayer* by the end of 1889 left its early day brand advisor, *Gehe*.<sup>221</sup> The reason is to be found in the German legal system of these days: If a phantasy name was included in a design/label, the word itself was not protected. Although nobody had the right to use the manufacturers name and plant mark (“Bayer”), Phenacetin could be legally copied.<sup>222</sup> Only in countries where *Bayer* had obtained an explicit brand protection it urged competitors not to violate its rights.<sup>223</sup> Finally *Bayer* accepted the incorporation of the brand into the German Pharmacopoeia in 1890 without protest.<sup>224</sup> This obliged all doctors, pharmacists and in the end also manufacturers to use the term and thus *Bayer* implicitly renounced its rights to an individual mark (*Individualzeichen*).<sup>225</sup> *Bayer’s* first initiative to claim individuality of the brand was to register it after the new law in 1894. Nevertheless in 1896 Schering achieved that *Bayer’s* trademark “Phenacetin” was erased by the authorities, mostly because it was inscribed into the 1890 pharmacopoeia. An

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<sup>216</sup> Bernsmann, ‘Arzneimittelforschung’, p. 671; Kebler, *Adulterated Drugs*, p. 35. The US trademark number was 16392. Cf. Anonymous, ‘New and Non-Official Remedies’.

<sup>217</sup> Anonymous, ‘Zum Wortschutz “Phenacetin”’; At the same time a patent for the product was applied and finally granted in the USA. (Nr. 400086 application filed June 29, 1888, granted March 26, 1889).

<sup>218</sup> A patent could not be granted in Germany due to a publication by a Bayer chemist, Hinsberg, in 1887. Cf. Hinsberg, ‘Wirkung des Acetphenetidins’; Farbenfabriken Bayer, *Geschichte*, p. 516, 525; McTavish, ‘Bayer’; Cf. Kent, *Reichsgesetz*, p. 95f, 105. In the US also the second brand was protected (nr. 18637).

<sup>219</sup> Riedel had elaborated a production process of an essential intermediate for Phenacetin by December 1888 and obtained a German patent on it in August 1889 (Nr. 48543). Riedel was followed from 1890 by Hoechst, Schering, Knoll and others. Cf. Wimmer, *Wir haben*, p. 115; Anonymous, ‘Entscheidung’; Bayer also negotiated with competitors about a (temporary) stop of Phenacetin production. Aufsichtsratsprotokolle, p. 167. BAL.

<sup>220</sup> My translation. Letter Böttinger to Duisberg, 20.01.1889 BAL 271/2 Vol.1; Rinsema, *natuur*, p.175.

<sup>221</sup> Farbenfabriken Bayer, *Geschichte*, p. 439.

<sup>222</sup> Soon labels denominated „Phenacetin-Knoll“, „Phenacetin-Riedel“etc. were registered.

<sup>223</sup> Anonymous, ‘Das Waarenzeichen “Phenacetin”’; Anonymous, ‘Nochmals zum Wortschutz’, p. 619.

<sup>224</sup> It had previously (1889) been incorporated in the Prussian Pharmacopoeia. Nieberding, *Unternehmenskultur*, p. 45.

<sup>225</sup> Anonymous, ‘Zum Wortschutz “Phenacetin”’, on of the loss of Phenacetin’s individual character and on the relationship patent-brand see Altschul, ‘Wortschutz’.

attempt to erase “Antipyrin” however was not successful due to the fact that Hoechst also possessed a patent on the production process of the good.<sup>226</sup>

## VII. Conclusion

The pharmaceutical industry is a classical “science-based” industry.<sup>227</sup> Mostly the rise of the chemical industry (including pharmaceuticals) before World War I is thus explained in literature by the incorporation of science, especially chemistry, into production. This paper suggests that in the case of the German pharmaceutical industry which dominated world pharmaceutical production in 1913 neither science nor firm-based resources and capabilities alone can explain the phenomenal rise of this branch. Instead, a co-evolutionary research design is adopted here which analyses management decisions and three main areas of connections between firms and their surrounding: Science, legislation/jurisdiction, and cooperation.

Among management decisions the most prominent issue treated here is the question to what extent a firm invested in the development of (internal or external) R&D capabilities to produce patented and trademark-protected products, called specialities. These specialities with a high scientific content provided superior returns-on-sales than dyes and wholesale drugs— a possible explanation for management to enter or expand this business. Therefore this paper analyses the size of each company’s speciality business. It can be shown that although the public increasingly demanded this product category a prototypical path of learning uniquely oriented towards speciality production did not exist. Rather companies followed different strategies according to their previously developed learning bases: former pharmacies continued to produce large quantities of diverse fine chemicals and alkaloids, whereas former drug wholesalers were most dynamic in developing new specialities and former dye producers nearly exclusively concentrated on specialities.

A development of specialities was only possible due to scientific developments in two closely related disciplines: medicine and chemistry. After the conquest of Alsace-Lorraine and the German unification in 1871 Strasbourg university pioneered interdisciplinary pharmaceutical research including pharmacologic testing of discovered substances. This model spread to other universities and was copied by some companies. Furthermore commercial ties existed between researchers and the industry.

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<sup>226</sup> Wimmer, *Wir haben*, p. 97. Due to the patent no other firm could legally produce Antipyrin and therefore the brand could also only be known for Hoechst’s product and didn’t lose its individuality.

<sup>227</sup> Henderson et al., ‘Industry’, p. 270.

To generate monopoly profits with specialities among institutions intellectual property rights play the most crucial role. In times when intellectual property protection did not guarantee these profits, e.g. before 1894 when word marks (brands) could only limitedly be registered in Germany or after 1905 when important patents were about to expire, industry massively lobbied politics for improved institutions or decided to self-regulate internationally the production of generics (*Freia*-contract).

Finally, the industry could not have risen before World War I without an important tendency towards cooperation. Two fields of cooperation can be differentiated: profit-sharing agreements and business associations. The first aimed at limiting competition to lower marketing-related costs and stabilize prices. The second sought to fight against opposing groups which intended to reduce profit margins of specialities. After cartels were officially legalized in Germany (1897) three profit sharing agreements existed in pharmaceuticals: The *Dreibund* (*BASF, Bayer, AGFA*), the *Dreiverband* (*Hoechst, Cassella, Kalle*)<sup>228</sup> and the *IG Pharma* (*Knoll, Gehe, Riedel, Boehringer M, Merck*). The most important business associations were the “Verband der chemisch-pharmazeutischen Großindustrie e.V.” (*Cepha*) and the “Zentralauskunftsstelle für Markenschutz” (*Zema*) which finally merged in 1924.

This paper is conceptualized as a branch study, including for the first time all mayor players on the German pharmaceutical market before World War I. Along with a confirmation of Murmann’s (2003) co-evolutionary approach, this article has done pioneer work because so far fundamentals of economic performance in German big pharmaceutical business have often been neglected in literature. An annex with sales, profits and number of workers lays the ground for further studies.

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<sup>228</sup> Schröter/Travis, ‘Issue of different mentalities’, p. 107.

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H1/57:

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H5/48b:

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H5/48b

-Annex to letter Boehringer Mannheim to IG 23.08.1915 [Speciality Sales]

H5/10c

-Gehe an I.G. Pharma, 18.02.1910.

H5/43:

-IG Pharma contract, 31.10.1907

-Calculation of profit quotas for all IG members 1899-1904

H5/9c:

-Knoll to IG Pharma, 11.08.1909

-Riedel to Merck, 02.08.1908

J1/244:

-Belegschaftsentwicklung

**Roche Diagnostics Archiv Mannheim (RDA)**(no shelf numbers):

-Gedenkblatt C.F. Boehringer & Soehne 1859-1909

-Preisliste C.F. Boehringer Soehne, February 1912

-Therapeutisches Vademecum, different volumes

**Author's own archivalia:**(no shelf number):

-Trypaflavin. Ein Wundantiseptikum, überreicht von Leopold Cassella & Co., G.m.b.H, Frankfurt a.M., Juli 1917.

**Sächsisches Wirtschaftsarchiv e.V. Leipzig (SWA)**Bestand U 107 AWD/von Heyden AG:Sign. 10:

- Jahresrechnung (Geschäftsberichte) der chemischen Fabrik von Heyden 1895-1898

Sign. 11:

- Abschlüsse Originale 1878-1918

Sign. 13:

-Jahresrechnung (Geschäftsberichte) der chemischen Fabrik von Heyden 1908-1920

Sign. 2821:

-Vertrag Chemische Fabrik auf Actien & Dr. F. von Heyden [copia vidimata], 06.10.1877

-Schering Jahresabrechnung 1884 und 1885

-Vertrag Hofmann & Schoetensack mit Convention, 23.09.1884, Anlage A

- Contract Heyden with A. Klipstein, 03.12.1897

Sign. 2820:

-G. Simon to A. Klipstein, 01.02.1901;

-Prospectus Saccharine [1902]

Sign. 2819:

-Vertrag Salicylsäure-Convention & Georg Carl Zimmer 17.12.1893

Sign. 2:

-Vertrag Heyden, Schering, Burgoyne Burbridges Cyriax et Farries, A & M Zimmermann, November 1877

Sign. 30:

- Aufsichtsratsprotokolle ab 1899

-Letter F.v.H. to Chemische Fabrik von Heyden AG, 18.08.1903

**Abbott-Knoll Archiv (AKA):**ZA 34:

Knoll's Mitteilungen für Ärzte, Jubiläumsausgabe 1886-1936

FA 030:

-Statistik der Specialpräparate Verkäufe & Kosten länderweise 1898 bis 1909.

J 006:

-Verzeichnis der Specialpräparate nebst Alkaloidmarken

F A 110:

-IG Pharma contract: 01.12.1906

J 153:

-Knoll AG Development and Products

F A 083

-Letter Merck to IG Pharma, 13.10.1916

-Memorandum Boehringer Mannheim-Waldhof to IG Pharma, 03.10.1916

## APPENDIX

Fundamentals of economic performance (for sources see below):

Table 7: Pharmaceutical sales 1875-1913 in M million (grouped according to data availability)

Year	MER	HEY	RIE									
1875	2.5	0.1	0.5									
1880	3.0	0.9	1.1	HOE								
1885	3.8	1.7	1.3	0.1	KAL	BAY						
1890	4.7	2.7	2.0		0.3	2.1	AGFA					
1895	6.2	3.7	2.7			3.6	0.04					
1900	10.3	5.9	4.6		0.3	7.3	0.1	ZIM	BOE M	GEH	KNO	
1905	13.0		6.1	3.6	0.3	9.1	0.3	3.4	7.8	9,0	2.7	BOE I
1910	18.6	12.2	9.4	6.4		13.9	0.6	3.1	7.1	10,0	3.8	1.7
1913	26.2	15.1	11.8	12.9	0.6	21.4	0.7	3.5	10.1	10.6	4.9	2.7

Table 8: Pharmaceutical profits 1875-1913 in M million (grouped according to data availability)

Year	MER	HEY					
1875	0.3	0.04					
1880	0.3	0.2					
1885	0.8	0.6					
1890	0.5	1.0	ZIM				
1895	0.8	0.7	0.4	BOE M	GEH	KNO	
1900	1.1	0.8	0.4	0.7	0.4	0.6	RIE
1905	1.4	0.4	0.2	0.5	0.4	0.5	0.5
1910	3.5	0.8	0.4	0.9	0.3	0.6	0.8
1913	3.7	1.2	0.4	1.3		1.0	0.7

Table 9: Workers in pharmaceutical production (grouped according to data availability)

Year	MER	HEY	RIE	BOE M		
1875	196	15	57	20		
1880			59	60		
1885			54		GEH	KNO
1890					200	27
1895	595	340	250	360	200	61
1900	777	700	266	400	250	70
1905	980	720	450	450	250	112
1910	1270	1147	550	440	250	176
1913	1629	1432	730	600	330	259

### Sources of tables and figures:

**Tab. 1.** a) 1872 numbers: *Merck*: EMA Geheimbuch 1850-1880; *Boehringer*: RDA no shelf number: Gedenkblatt; *Trommsdorff*: Huhle-Kreutzer, Entwicklung, p. 157; *Riedel*: Anonymous, 'Bestehen'; *Heyden*: Schlenk, Fabrik; b) 1913 numbers: *Merck/Gehe/Riedel/Boehringer/Knoll*: EMA R15/14a; *Hoechst*: 6/ (RFL 28); *Bayer*: BAL 15/D.1; AGFA: BAL 5/E.A.24; *Schering*: only specialities: SchA B2-1362; *Heyden* SWA U 107 AWD/v. Heyden Sign. 13; *Boehringer* f. only alkaloids: Personal communication with Dr. M. Siebler of Boehringer Ingelheim Archives; *Zimmer*: EMA H1/157; *Kalle*: numbers survived only for 4 months and were multiplied by three, StA W WA 3 218; *Bayer*: BAL 15/D.1.

**Tab 2.** Foundation dates mostly according to Wenzel, *Adressbuch*, different years. POE dates are taken from corporate anniversary publications which are cited for each company in the business historical part.

**Tab 3.** *Hoechst*: 6/ (RFL 12); *Bayer*: BAL 10/1.2

**Tab 4.** Sources: *Merck/Gehe/Knoll*: EMA H5/10a, EMA R15/14a.

**Tab 5.** Sources: *Merck/Boehringer Mannheim/Knoll/Riedel*: For speciality sales: Annex to letter Boehringer Mannheim to IG 23.08.1915, EMA H5/48b; For overall sales: Anlage Gesamtumsatz der IG nach Ländern geordnet in: EMA F3-13a until -16a, EMA R15/14a, EMA H5/10a; *Schering*: SchA B2-1362; *AGFA*: BArch. R8128-15765 and 15766, BArch R8128-16234 and -16235; BAL 5/E.A.24; *Hoechst*: HoeA 2/001 (alt: C/2/1/b) Jahresberichte Pharmazeutika 1908-1910.

**Tab 6.** Sources: SchA S1/6 and 2/10.

**Tab 7.** Some numbers slightly differ from the corresponding year (+/- 1 year) due to diverging balancing periods or data availability. *Merck*: EMA Geheimbuch 1850-1880, Geheimbuch 1880-1899 (without shelf numbers), EMA F3-1a until -15a; EMA R15/14a; *Heyden*: SWA U 107 AWD/v. Heyden Sign. 10, Sign. 11 and Sign. 13; *Riedel*: HCAS P3 and P4, Anonymous, 'Bestehen', p. 222; *Hoechst*: HoeA 6/ (RFL 12), HoeA 6/(RFL 11), 2/001 3 and 2/001 4; *Kalle*: StA W WA 3 170; StA W WA 3 218; Sta W WA 3 537; *Bayer*: BAL 15/D.1; *AGFA*: BArch. R8128-15757 until - 15766, BArch R8128-16234 until 16235; BAL 5/E.A.24; BAL 5/E.A.16; *Zimmer*: EMA H1/157; *Boehringer Mannheim/Gehe/Knoll*: Anlage Gesamtumsatz der IG nach Ländern geordnet in: EMA F3-13a until -16a, EMA R15/14a, EMA H5/10a; *Boehringer Ingelheim*: Personal communication with Dr. M. Siebler of Boehringer Ingelheim Archives.

**Tab 8.** Some numbers slightly differ from the corresponding year (+/- 1 year) due to diverging balancing periods or data availability. Former dye companies are excluded because data is unavailable for only the pharmaceutical business. *Merck*: EMA R15/61, EMA F3-1a until 15a; EMA R15/14a; *Heyden*: SWA U 107 AWD/v. Heyden Sign. 10, Sign. 11, Sign.13; *Riedel*: HCAS P3 and P4; *Zimmer*: EMA H1/157; *Boehringer Mannheim/Gehe/Knoll*, EMA R15/14a, EMA H5/10a; Burkert, Interessengemeinschaft, p. 139f; EMA H5/43.

**Tab 9.** Some numbers slightly differ from the corresponding year (+/- 1 or 2 years) due to data availability. Former dye companies are excluded because data is unavailable for only the pharmaceutical business. *Merck*: EMA J1/244, EMA F3-1a until -15a, EMA R15/14a, Vershofen, Wirtschaftsgeschichte, p.40, Wiener Weltausstellung, p.113; *Heyden*: SWA U 107 AWD/v. Heyden Sign. 10, Sign.13, Sign. 3203; Schulz-Thomas: 100 Jahre, p. 159; *Riedel*: Führer, p. 52f, Riedel, 150 Jahre, p. 56, Anonymous, 'Bestehen', BArch R3101-20707, HCAS L 27 (1907), Anonymous, 'Riedel'; *Boehringer Mannheim*: RDA no shelf number: Gedenkblatt. From 1890-1913 data is mostly from Wenzel, *Adressbuch*, different volumes, and for limited stock companies also from *Handbuch der Deutschen Aktien-Gesellschaften*, different years.

**Fig. 1:** For pharmaceutical sales see source of Tab. 7. For overall sales: *Bayer*: BAL 15/D.1; *Hoechst*: 6/(RFL 11); *Kalle*: StA W WA 3 170; StA W WA 3 218; *AGFA*: BArch. R8128-15757 until - 15766, BArch R8128-16234 until 16235; BAL 5/E.A.24; BAL 5/E.A.16.

**Fig. 2:** EMA F3-1a until -15a; EMA R15/14a, EMA H5/45.

### Business histories (according to 1913 sequence in Tab. 1):

Chemische Fabrik E. Merck OHG, Darmstadt near Frankfurt (Merck): In 1668 the pharmacist Friedrich Jacob Merck acquired a pharmacy in Darmstadt and his descendant Heinrich Emanuel Merck together with his sons Carl, Georg, and Wilhelm started the industrial production of alkaloids in 1827.<sup>229</sup> Merck also started wholesaling of drugs, which rose to make 1/3 of overall sales at the turn of the century.<sup>230</sup> Alongside with Gehe and Riedel, this made Merck one of the biggest drug wholesalers in Germany.<sup>231</sup> Although Merck developed own specialities the company was more a large pharmacy store than a speciality producer (Tab. 5).<sup>232</sup> The company remained an ordinary partnership (OHG) and was not incorporated until the after World

<sup>229</sup> Burhop, 'Pharmaceutical research', p. 480; Galambos/Sturchio, 'Transnational Investment'

<sup>230</sup> Tätigkeitsbericht W. Conzen, EMA F6/7, p. 24. Merck listed 10.000 products in its 1890 price list. Bernschneider-Reif et al, *Was der Mensch*, p.53. In 1898/1899 it was estimated to be 37% of overall sales. Jahresbericht 1898-1899. EMA F3/3a 001-030; Cf. Stube, *Ueber Arten und Formen*, p. 284.

<sup>231</sup> Stube, *Ueber Arten und Formen*, p. 284.

<sup>232</sup> Bartmann, *Tradition*, p. 102 calls Merck a 'large pharmacy' (Großapotheke) and attributes the relative loss of competitiveness to the big and lower profit-making product portfolio.



War II period (1953).<sup>233</sup> Merck's most important specialities were Strypticin (1897), Dionin (1898) and especially Veronal (1903).<sup>234</sup> In 1914 net sales were generated by: wholesaling (22.7%), own alkaloids (16.5%), Veronal alone (4.3%) and other specialities (10.8%) of sales.<sup>235</sup>

Farbenfabriken vorm. Friedr. Bayer & Co. AG, Elberfeld near Düsseldorf (Bayer): Bayer was founded in 1863 by the dye trader Friedrich Bayer and the dyer Friedrich Weskott to start the production of magenta. It was incorporated in 1881 after the death of both founders. Bayer's son in law (C. Rumpff) became chief of the supervisory board and he paid on his own account in 1883 three young university chemists, C. Duisberg, O. Hinsberg and M. Herzberg to start different research projects. Carl Duisberg became chief of Bayer's research division after inventing various new dyes and winning the Congo-red case against AGFA.<sup>236</sup> In 1887 he proposed Hinsberg to experiment with pharmaceuticals, who soon invented Bayer's first pharmaceutical, Phenacetin, in 1887.<sup>237</sup> Bayer's long term blockbuster was Aspirin (acetylsalicylic acid), widely marketed from 1899 on.<sup>238</sup> In 1913 pharmaceuticals accounted for 18.9% of total sales.

Chemische Fabrik von Heyden AG, Radebeul near Dresden (Heyden): Founded in 1874 by the chemist Dr. Friedrich von Heyden for the purpose of exploiting Prof. Kolbe's salicylic acid patents, the company was financed in 1876 by Gustav Siegle (see BASF).<sup>239</sup> Other specialties were Salol (1885), Duotal (1890) and artificial sweeteners as Dulcin or Crystallose (1891). To finance large scale production of sweeteners the company was transformed first into a Limited (G.m.b.H.) in 1896 and into a joint stock company (AG) in 1899.<sup>240</sup> When Bayer tried to obtain patents for Aspirin in Germany from 1898 on, Heyden objected and the patents were denied. Heyden also marketed acetyl salicylic acid, first under its chemical denomination and later as "Acetylin". The two companies soon signed convention agreements on the marketing of salicylic acid products.<sup>241</sup> In 1903 Heyden started manufacturing synthetic indigo but was not allowed to produce large quantities until 1913.<sup>242</sup> Still pharmaceuticals generated 94.4% of total sales in 1913.<sup>243</sup>

Farbwerke vorm. Meister, Lucius & Brüning AG, Höchst a. M. near Frankfurt (Hoechst): Originally founded in 1862 to produce aniline dyes by the chemist Eugen Lucius and the merchants Carl. F. W. Meister and Ludwig Müller, the official foundation date is 1863 – the year the founders were joined by Adolf Brüning.<sup>244</sup> It was incorporated in 1880 and marketed its first pharmaceutical Kairin three years later.<sup>245</sup> Big blockbusters were Antipyrin (1884) and Pyramidon (1897). In the 1890's Hoechst mostly marketed vaccines and sera.<sup>246</sup> Hoechst's biggest seller was the chemotherapeutic Salvarsan (1910) and its derivatives, such as Neosalvarsan (1912). In 1913 pharmaceuticals accounted for 14.2% of total sales.<sup>247</sup>

J. D. Riedel AG, Berlin (Riedel): Johann Daniel Riedel founded his company, then a pharmacy, in 1814 in Berlin. In 1827 he started to produce quinine but soon failed.<sup>248</sup> Instead he established a drug wholesaling business. He died in 1843 and first his son (until 1886) and then his grandsons, Paul and Fritz Riedel took

<sup>233</sup> The company was incorporated becoming E. Merck AG in 1953. This was again changed to the form of a commercial partnership limited by shares (KGaA) in the 1970s.

<sup>234</sup> For the relevance of Veronal for Merck see Burhop, 'Pharmaceutical Research'. Its overall importance was even bigger than Burhop's (p. 489) estimates for (gross) profits suggest. Veronal's accumulated gross profit (royalties not yet deducted) is 3.1 M million for the years from 1903/1904 until 1913 (excluding 1910). Burhop's source material (EMA S6/22) e.g. lists Veronal numbers only from 1913 (i.e. not from 1903) on, whereas Strypticin profits are indicated from product launch (1897) on. Sales in 1913 (in relation to overall sales) were 1% (Strypticin) and 3.9% (Veronal). Jahresbericht Merck 1903/1904 until 1913, Anlage: Präparate über die abgerechnet wird. EMA F3/8a until 16a, EMA R15/14a.

<sup>235</sup> Net sales here mostly means: gross sales less a) deliveries of raw morphia to Knoll and b) packaging. Jahresbericht E. Merck 1914, Anlage 13. EMA H5/45.

<sup>236</sup> Seckelmann, *Industrialisierung*, p. 236ff.

<sup>237</sup> Farbenfabriken, *Geschichte*, p. 624.

<sup>238</sup> Wimmer, *Wir haben*, p. 265, 317. Aspirin was still Bayer's the most selling product in the 1920s and beginning 1930s.

<sup>239</sup> Schlenk, *Fabrik Heyden*, p.26; Binder, 'Gustav Siegle', p. 294: Siegle's father was pharmacist.

<sup>240</sup> *Ibd.* p. 41.

<sup>241</sup> E.g. Pharmaceutische Salicylsäure-Convention, technische Salicylsäure-Convention, Abrechnung 1910. BAL 15/D.5.A Finanzwesen Umsätze Pharmazeutika allg. 1894-1914

<sup>242</sup> *Handbuch der Deutschen Aktien-Gesellschaften* 1913/1914, p. 1581. The supreme court (Reichsgericht) had allowed Heyden in 1908 to produce indigo by another than BASF's process. Cf. *Zeitschr. F. ang. Chemie* 22 (1909), p. 277. Nevertheless Heyden's annual report of 1911 states that there had been a pendent dispute of patent infringement. Jahresrechnung der chemischen Fabrik von Heyden 1911, S. 3 SWA U 107, Sign. 13 und Schlenk, *Fabrik Heyden*, p. 53.

<sup>243</sup> Jahresrechnung von Heyden 1913, p.3f. SWA U 107 Sign. 13. Heyden's sales were balanced by plant and not by product. As indigo was only produced in Heyden's Weißig plant, and as the Weißig sales remained nearly constant from 1910-1912 it is reasonable to argue that the increase in sales of 1913 mainly relies on the newly established large scale production of indigo.

<sup>244</sup> *Farbwerke 1863 – 1913*: Pinnow, *Wiederkehr*.

<sup>245</sup> Wimmer, 'Tradition und Transformation', p. 182.

<sup>246</sup> Wimmer, *Wir haben*, p. 157.

<sup>247</sup> Salvarsan alone made 6.3% of sales. But total sales numbers for 1913 differ. According to another source the value is a little less (12.8%) with Salvarsan generating 5.7% of overall sales. HoechstA RFL 28 Werk Hoechst 1906-1924, Umsatz u. Verkaufstatistiken versch. Jahrgänge, 6/.

<sup>248</sup> Huhle-Kreutzer, *Entwicklung*, p.173.

over charge. The company started to produce Phenacetin and Sulfonal at the beginning of the 1890s.<sup>249</sup> The company also produced an artificial sweetener Dulcin (1892). In 1905 the company was incorporated. Some of its specialities were Salipyrin (1890), Borneyval (1903), Mergal (1907), Aperitol (1908), Hexal (1911) and Yohydrol (1912).<sup>250</sup> In 1913 specialities accounted for 19.5% of total sales.<sup>251</sup>

Gehe & Co. AG, Dresden (Gehe): Founded in 1835 by the merchant Franz Ludwig Gehe the company took over the drug trading business of Gehe & Schwabe. Gehe started a small scale extraction of alkaloids in 1859 and a plant was opened in 1866. International sales of extracts and alkaloids rapidly expanded in the 1880s and 1890s.<sup>252</sup> The company was incorporated in 1903.<sup>253</sup> Nevertheless Gehe continued to generate sales mainly in wholesaling of drugs and not in galenic production.<sup>254</sup> Galenicals only generated 6.9% of total sales in 1910.<sup>255</sup> In Germany Gehe supplied both smaller wholesalers (2/3) and pharmacies (1/3).<sup>256</sup> Among the few specialities were Ureabromin (1910), Agobilin (1913) and Calmonal (1915).<sup>257</sup>

C. F. Boehringer & Soehne GmbH, Mannheim (Boehringer M): Founded in 1859 in Stuttgart by the drug trader Christian Friedrich (C. F.) Boehringer and his two sons Christian Gottfried (C. G.) and Christoph Heinrich (C. H.) to continue wholesaling and to start the production of quinine.<sup>258</sup> Both C. G. and C. F. Boehringer died in the 1860's, which left C. H. in charge until his death in 1882. After the death his son Ernst Boehringer bought the company from his mother, paid the heirs out and associated himself with Dr. F. Engelhorn, son of Friedrich Engelhorn (see BASF), in 1883.<sup>259</sup> To expand production moved twice: First to Mannheim in 1870 and second to Mannheim-Waldhof from 1882-1884.<sup>260</sup> Boehringer M mostly produced alkaloids such as codeine.<sup>261</sup> Its first specialty was Eseridin (1888), an alkaloid. Ferratin (1892), its liquid form Ferratose (1894) and Lactophenin (1894), an antipyretic, were big sellers.<sup>262</sup> Still in 1916 non-patented pharmaceuticals generated 53.5% of total sales compared to 9.2% for specialities.<sup>263</sup>

Knoll & Co. OHG, Ludwigshafen near Frankfurt (Knoll): Knoll was founded in 1886 by the chemist Dr. Albert Knoll, and the merchants Hans Knoll and Max Daege for the extraction of opiates, mostly Codeine.<sup>264</sup> The three founders had all previously been working for Gehe.<sup>265</sup> Dr. A. Knoll developed a production process for Antipyrin in 1890 and so the founders participated in the setting up of factory in Basle, Switzerland, in 1891.<sup>266</sup> Specialities were e.g. Theobromin (1889), Diuretin (1894), Tannalbin (1895), Overadentriferrin (1900) and Bromural (1906).<sup>267</sup> Specialities accounted in 1916 for about 75% of overall sales, whereas alkaloids accounted for the remaining 25%.<sup>268</sup>

<sup>249</sup> Notizen des Aufsichtsratsvorsitzenden Ernst v. Eynern zur Firmengeschichte, p. 100. BAL 1/5.2.

<sup>250</sup> For more specialities cf. Riedels Berichte /Riedels Mentor, Vol. 58 (1914), Teil IV Riedel's pharmazeutische Spezialpräparate.

<sup>251</sup> Protokollbuch J. D. Riedel Aktiengesellschaft 1913-1918, p. 53. HCAS P4; Propaganda Boehringer an IG, 23.08.1915, Übersicht J. D. Riedel, EMA H5/48b.

<sup>252</sup> *100 Jahre Gehe 1835-1935*, p.56.

<sup>253</sup> *Gehe & Co. Aktiengesellschaft Dresden 1835-1910*.

<sup>254</sup> Protokoll der Sitzung im Park-Hotel in Mannheim am 24. 11.1905, p. 2.EMA R 15/16b; Pharmazeutische Spezialitäten 'Gehe', 11.11.1911; Spezialitäten – Betrieb Dresden 06.11.1911, p.2. Both EMA H5/30. Gehe is said to generate two thirds of its sale with wholeselling.

<sup>255</sup> Galenische Präparate, Gehe to I.G. Pharma, 17.03.1913. EMA H5/33. For 1912 it's even less (5.9%).

<sup>256</sup> Gehe an I.G. Pharma, 18.02.1910. EMA H5/10c.

<sup>257</sup> Gehe's partners of the IG Pharma (see below) proposed Dresden to introduce new easily made products like medical chocolates, pocket pharmacies etc. or signed them some products over e.g. Tannyl, Triferrin-(Malthyl) or Triferrol by Knoll. Cf. Freia-Liste, SchA S1/006. Spezialitäten – Betrieb Dresden 06.11.1911, p.2. EMA H5/30

<sup>258</sup> C.G. Boehringer was a merchant and C.F. a pharmacist. *Denkschrift der C. F. Boehringer*, p. 3. Siebler, *Menschen*, p.16; Gedenkblatt C.F. Boehringer & Soehne 1859-1909 RDA without shelf number. The newly established company took over the drug wholesale business which C. F. Boeh-ringer and his friend C. G. Engelmann had been running in Stuttgart since 1817. A quinine plant was bought in 1859 from Simeons Ruth & Co., Hoechst. Facilities were moved to Stuttgart and production started in 1861.

<sup>259</sup> Siebler, *Menschen*, p.23.

<sup>260</sup> Siebler, *Menschen*, p.20f.; *Denkschrift der C. F. Boehringer*, p. 5.

<sup>261</sup> The only available product sales rely on codeine convention balances. After Ingelheim left the convention in 1908 and started massive competition Boehringer M's codeine sales fell both in quantity and in price. While in 1907 codeine alone made at least 3.9% of Boehringer M's total sales, this number fell to 2.8 % (1908) and 1.9% (1909). Quantities: Codein-Verkaufe in Europa (lt. Conventionsabrechnung). EMA H5/21. Average prices: Merck-Jahresberichte 1907-1909, F3-11a-13a, Konventionen.

<sup>262</sup> *Denkschrift der C. F. Boehringer*, p. 29. Cf. Schmiedeberg, 'Ueber das Ferratin'.

<sup>263</sup> [C.F. Boehringer Soehne], I.G. Jahres-Bericht -1917-, p.3, EMA R15/14b. The second largest product group, technical products, had a share of 28% of total sales whereas odorants accounted for exactly the same number of sales as specialities (9.2%).

<sup>264</sup> Anonymous, '50 Jahre Knoll A.-G.'

<sup>265</sup> A. Knoll from 1881-1885. *100 Jahre im Dienste*, p.18.

<sup>266</sup> *100 Jahre im Dienste*, p.34. Two years later Knoll & Co. set up an own factory and warehouse in Basle.

<sup>267</sup> For Knoll's specialities see Knoll's Mitteilungen für Ärzte, Jubiläumsausgabe 1886-1936., p. 11. AKA, ZA 34.

<sup>268</sup> Most important products that year were Tannalbin (24.9% of total sales), Bromural (19.4%), Digipuratum (18.9%) and Diuretin (8%). IG Jahresbericht für 1917. MA R15/14e; Anlage No. 7 zum Jahresbericht per 1917. EMA R15/14 e; In 1908

Vereinigte Chininfabriken Zimmer & Co, GmbH, Frankfurt a. M. (Zimmer): The company resulted from a merger in 1887 of the quinine companies Friedr. Jobst, Feuerbach, and Conrad Zimmer, Frankfurt a. M.<sup>269</sup> Therefore the foundation dates of both companies, 1807 and 1837, were carried on.<sup>270</sup> E. Merck became a partner so that in 1888 the production of cocaine could be started.<sup>271</sup> The company was transformed into a Limited (GmbH) in 1892.<sup>272</sup> Specialities were e.g. Euchinin (1896), Validol (1897)<sup>273</sup>, Eunatrol (1897) and Optochin (1913).<sup>274</sup> Zimmer had an extraordinary export dependency because 90% of Zimmer's sales were generated outside of Germany.<sup>275</sup>

C. H. Boehringer Sohn GmbH, Nieder-Ingelheim (Boehringer I): Founded in 1885 by the chemist Albert Boehringer, brother of Ernst Boehringer (see *Boehringer Mannheim* above) to produce tartar and tartaric acid.<sup>276</sup> The company was renamed and became a limited in 1893.<sup>277</sup> In 1895 large scale production of lactic acid, mainly for leather tanning, started.<sup>278</sup> After the Boehringer family had lost its share in the Mannheim alkaloid business (1892), Boehringer I tried to foster its own alkaloid production.<sup>279</sup> Alkaloid production started in Ingelheim in 1905.<sup>280</sup> Its first specialty, Laudanon, was marketed in 1915.<sup>281</sup> Boehringer I's alkaloid business made the company become Germany's tenth biggest pharmaceutical company in less than ten years (Tab. 1).

Chemische Fabrik auf Actien vorm. E. Schering AG, Berlin (Schering): The "green pharmacy" was bought in 1851 by Ernst Schering and soon afterwards the production of fine chemicals, mostly for photography started.<sup>282</sup> The company was incorporated in 1871. Soon afterwards it produced salicylic acid which provoked a strong fight with Heyden.<sup>283</sup> After the introduction of a federal patent act (1877) Schering recognized Heyden's rights and both companies marketed the product together.<sup>284</sup> In 1884 salicylic acid generated at least 11% of total sales.<sup>285</sup> Salicylic acid yielded on average 37.9% of the annual gross-profits from 1886-1893 and was mainly sold outside of Germany.<sup>286</sup> Other specialties were e.g. Piperazin (1890), Phenokoll (1894), Urotropin (1894), Medinal (1908) and Atophan (1911).<sup>287</sup> In 1913 specialties accounted for 15.9% of total sales.<sup>288</sup>

the ranking was: 1. Diuretin, 2. Tannalbin, 3. Santyl, 4. Bromural, 5. Styptol. Quantities: Statistik der Specialpräparate Verkäufe & Kosten länderweise 1898 bis 1909. AKA FA 030; Prices: Verzeichnis der Specialpräparate nebst Alkaloidmarken, AKA J 006. Cf. Anonymous, 'Geschäftliches'.

<sup>269</sup> Ziegler, *Familie Jobst*, p.128ff; This company is not to be confused with a company of Georg Carl Zimmer in Mannheim producing salicylic acid. Wenzel, *Adressbuch*, Vol.5 (1896), p. 404. Vertrag Salicylsäure-Convention & Georg Carl Zimmer 17.12.1893 SWA U 107 Sign. 2819.

<sup>270</sup> Wenzel, *Adressbuch*, Vol. 13 (1914), p. 456.

<sup>271</sup> *Denkschrift der C. F. Boehringer*, p. 41f.

<sup>272</sup> *Ibd.*, p. 41. Merck held 22.1% of all shares. Ziegler, *Familie Jobst*, p. 132.

<sup>273</sup> Zimmer's mainly sold product was quinine. But especially Euchinin and Validol repeatedly generated big parts of the net profits due to a high price volatility in the raw china-bark. Protokollbuch, EMA H1/157.

<sup>274</sup> For a complete list of Zimmer's specialties see *Denkschrift der C. F. Boehringer*, p. 46f.

<sup>275</sup> Protokollbuch, p. 362ff. EMA H1/157. This provoked an existential crisis when World War I started. Even Merck was surprised by Zimmer's export dependency.

<sup>276</sup> Until 1910 Boehringer I listed 1884 as their foundation. Cf. Wenzel, *Adressbuch*, Vol.1-11, 1888-1910. From Wenzel's 1912 volume on the date is 1885.

<sup>277</sup> It carried now the name C.H. Boehringer Sohn, GmbH. Wenzel, *Adressbuch*, Vol 4 (1894).

<sup>278</sup> Siebler, *Menschen*, p.46ff. For an early advertisement in GB see, Benninga, *A History*, p.152.

<sup>279</sup> Siebler, *Menschen*, p.42. Rivalry about the name started with Boehringer M which ended in a Supreme Court decision in 1908, that Boehringer I had the right to use its name also for the sale of alkaloids.

<sup>280</sup> *Ibd.* p. 64. Cf. Wenzel, *Adressbuch*, Vol. 9 (1906) listed as alkaloids morphine, cocaine and codeine.

<sup>281</sup> Siebler, *Menschen*, p.85.

<sup>282</sup> Huhle-Kreutzer, *Entwicklung*, p. 185ff. Pharmaceuticals were only a small part of the portfolio.

<sup>283</sup> Schering/Holtz, *Rechtsstreit*. Cf. Jahresbericht Schering 1876, SchAB0-200/201.

<sup>284</sup> Vertrag Chemische Fabrik auf Actien & Dr. F. von Heyden [copia vidimata], 06.10.1877. SWA U 107 Sign. 2821; Vertrag Heyden, Schering, Burgoyne Burbridges Cyriax et Farries, A & M Zimmermann, November 1877. SWA U 107 Sign. 2. Transcription of P. Korn's manuscript, p. 10ff. SchA B5-0414; Glaugau, *Gründungsschwindel*, p. 235ff.

<sup>285</sup> Schering sold 40.208,57 Kg. of salicylic acid in 1884. Conventional prices in 1884 ranged from 14.5M/Kg. to 20.5 M/Kg depending on quantity, product quality and country to be sold in; Schering Jahresabrechnung 1884 und 1885; Vertrag Hofmann & Schoetensack mit Convention, 23.09.1884, Anlage A, Both SWA U 107 Sign. 2821.

<sup>286</sup> Transcription of Paul Korn's manuscript, p.4, 11, SchA S22-0017-0028; Huhle-Kreutzer, *Entwicklung*, p. 190 cofuses gross profit with sales; Cf. *Handbuch der Aktiengesellschaften*, 1896/1897, p.2.

<sup>287</sup> Lepsius, *Fünfzig Jahre*, p.15ff. Bayer produced Piperazin from 1892 on and received a patent in 1894. In 1895 Piperazin made 1.6% of Schering's total sales. Notizen des Aufsichtsratsvorsitzenden Ernst v. Eynern, p. 100. BAL 1/5.2. Piperazin Convention 4. Quartal 1910. BAL 15/D.5.A; Cf. Farbenfabriken, *Geschichte*, p. 429, 526.

<sup>288</sup> Total speciality sales 1913: 2.691 M million. List dated 02.05.1929. SchA B0-549/1. Atophan made 7.4% of total sales in 1913, followed by Urotropin (4.3%) and Medinal (1%). To calculate Schering's overall pharmaceutical sales (including not only specialties) for 1913 is very difficult with existing sources. No numbers survived e.g. for salicylic acid sales. Taking overall sales (including fine chemicals) is not viable because these include huge photochemical and camphor sales which other companies (Bayer, AGFA, Boehringer M) balanced differently. But Formalin, a disinfectant (369K M) and pure medical camphor (193K M) could be added. Cf. Pharmazeutische Zeitung Vol. 66. (1921), p. 912; Kobrak, *National Culture*, p. 367f.

Actiengesellschaft für Anilinfabrikation AG, Berlin (AGFA): Originally founded in 1867 by the chemists Paul Mendelssohn Bartholdy and Dr. C. A. Martius, the company became a joint stock company (Actiengesellschaft, AG for short) in 1873. Initially, the firm produced aniline dyestuffs and intermediates but it started a pharmaceutical production (Phenacetin) in 1892.<sup>289</sup> From 1892 onwards the firm also tested externally invented specialities for effectiveness and tried large scale production in their experimental laboratory.<sup>290</sup> Its first speciality was Chloroform-Anschütz (1894), an anaesthetic.<sup>291</sup> In 1913 its most selling drug was Acidol-Pepsin (1905).<sup>292</sup> Nevertheless pharmaceutical sales only counted for a little more than 1% of AGFA's total sales in 1913 (Fig. 1).

Kalle & Co. AG, Biebrich a. Rh. near Frankfurt (Kalle): Founded in 1863 by the chemist Dr. Wilhelm Kalle and the merchant, Jacob Alexander Kalle (his father) to produce aniline dyes. The company was incorporated in 1904.<sup>293</sup> Kalle produced e.g. the pharmaceuticals Jodol (1885), Antifebrin (1886), Dormiol (1898), Bioferrin (1904) and Neuronal (1904).<sup>294</sup> In 1908 Hoechst and Cassella together took over 88.8% of Kalle's total joint stock to avoid a merger of Kalle and Ciba.<sup>295</sup> Though formally independent, Kalle's pharmaceutical department was closely linked to Hoechst in marketing and research of drugs.<sup>296</sup> Whereas pharmaceuticals had accounted for 13.6% of sales in 1891 this number fell to 3.7% in 1913.

Chemische Fabrik H. Trommsdorff KG, Erfurt (Trommsdorff): The company was founded in 1837 by the pharmacist C. W. Hermann Trommsdorff in Erfurt to produce alkaloids.<sup>297</sup> The son of the founder, Hugo Trommsdorff, sold the company after the death of his father in 1885.<sup>298</sup> Its first specialty was Sozodol (1887), an antiseptic. The new owners sold the alkaloid business to E. Merck in 1893 for 275.000 M.<sup>299</sup> Sozodol-production remained in Erfurt until 1905 when it was moved to Aachen.

Badische Anilin- und Sodafabrik AG, Ludwigshafen near Frankfurt (BASF): Founded in 1865 by the owner of a gas work Friedrich Engelhorn, the chemists August and Carl Clemm and the banker Seligmann Ladenburg, BASF started to produce aniline dyes.<sup>300</sup> In 1873 BASF merged with its two most important sales agencies. One of these former agents (Gustav Siegle) who had become a member of the supervisory board called in 1882 for a start of a pharmaceutical production in Ludwigshafen.<sup>301</sup> The company obtained a first pharmaceutical patent for a green antipyretic, called Thallin, in January 1885 and started marketing the product only a few months later.<sup>302</sup> Although scientific results at the beginning seemed to be promising, the product turned out to be more poisonous than its biggest rival, Antipyrin (Hoechst).<sup>303</sup> In 1889 BASF's sales in Thallin were 31.000 M.<sup>304</sup> In 1889 and 1890 BASF lost two prominent supporters of pharmaceutical business (G. Siegle and H. Caro) as well as its chief Thallin production chemist (H. Kreis).<sup>305</sup> Nevertheless the company went on advertising Thallin as one of its products until 1894.<sup>306</sup> This product remained the only

<sup>289</sup> Bericht der Methylfabrik über die Fabrikation in den Monaten Juli, August, September 1892, BArch R8128-16210. In 1894 it also produced Antifebrin and Dermatol, cf. Jahresbericht über die Fabrikation in der Methylfabrik im Jahre 1894, BArch R8128-16212; Beiträge zur Geschichte, p. 9, BAL 5/E.44.

<sup>290</sup> Jahresbericht des Versuchslabors für das Jahr 1892, p. 4, BAL 5/E.A.26.

<sup>291</sup> Jahresbericht des Versuchslabors für das Jahr 1893, BAL 5/E.A.26. In 1896 AGFA already sold 869Kg of Chloroform Anschütz. Jahresbericht 1897, BArch R8128-15757. For a complete list of AGFA's pharmaceuticals see Vershofen, *Wirtschaftsgeschichte*, p. 90-91.

<sup>292</sup> Jahresbericht 1906, p. 110, BArchB R8128-15763; Jahresbericht 1913, p. 104, BAL 5/E.A.24. For AGFA's early history see Willstädter, *'Geschichte'*.

<sup>293</sup> Die Anilin-Farbenfabrik von Kalle & Co. in Biebrich 1883-1904. StA Wiesbaden WA 3 246, p. 5.

<sup>294</sup> *Ibid.*, p. 14; Vershofen, *Wirtschaftsgeschichte*, p. 44; Lysargin, WA 3 869.

<sup>295</sup> In 1913 Hoechst alone held 72.7% (3273/4500) of all shares of Kalle & Co. In exchange Biebrich had received only 4% of Hoechst's shares. *Handbuch der Deutschen Aktien-Gesellschaften 1913/1914*, p. 1550, 1601; Anlage 1, Beteiligung an fremden Unternehmungen, 01.12.1915, StA W WA 3 35. Cf. Interessen-Gemeinschaftsvertrag, 18.08.1916, p. 3, BAL 5/E.A.59; Plumpe, *I.G. Farbenindustrie*, p. 47.

<sup>296</sup> HoeA, Chronik der pharmazeutischen Abteilung Hoechst, p. 166f, 186.

<sup>297</sup> Huhle-Kreutzer, *Entwicklung*, p. 151. Wenzel, *Adressbuch*, Vol. 1 (1888), p. 226

<sup>298</sup> Huhle-Kreutzer, *Entwicklung*, p. 168f.

<sup>299</sup> Vertrag E. Merck mit H. Trommsdorff, 29.07.1892/17. 03.1893; Zirkular H. Trommsdorff 01.07.1893. EMA R1/42. Merck benefited from the acquisition of stock, property rights and staff because competition in alkaloids was reduced and the stock generated more money than Merck paid for it. A. Schumacher, *Tätigkeitsbericht*, p.12. EMA F6/12. Cf. Walter, 'Johan Bartolomäus Trommsdorff'

<sup>300</sup> Abelschauser, *BASF*. Engelhorn started his career as a goldsmith.

<sup>301</sup> Reinhardt, 'Alizarinblau' p.269. It seems to have been his personal ambition to recruit pharmaceutical scientific staff for BASF. Reinhardt, *Forschung*, p.149.

<sup>302</sup> The German patent Nr. 30426 was granted the 14.01.1885, and applied for the 18.06.1884. Cf. Reinhardt, 'Vom Alizarinblau zum Thallin' p.270.

<sup>303</sup> G. Vulpius, 'Über Thallinpräparate'; Eichengrün, 'Die Überproduction an neuen Arzneimitteln'; Ehrlich, 'Experimentelles'; Letter Filehne to board of the BASF, 2. August 1889, BASF UA P 84 Sonderprodukte, Pharmazie Arzneimittel; Anonymous, 'influence', p. 650.

<sup>304</sup> Geschichte der Badischen Anilin- und Soda-Fabrik, Kaufmännische Entwicklung, Vorgeschichte, Periode I und II, 1865-1888, p. 63. BASF UA T001. This sum is equivalent to 0,13% of total sales in 1889 (=23.156 M million).

<sup>305</sup> Reinhardt, *Forschung*, p.140-141; Reinhardt, 'Alizarinblau', p.272. Cf. Information on Kreis, BASF UA P 84 Sonderprodukte, Pharmazie Arzneimittel.

<sup>306</sup> Wenzel, *Adressbuch*, Vol 3 (1892) and 4 (1894).

pharmaceutical product throughout the German Empire.<sup>307</sup> Finally it sold the Thallin patents to Merck in 1894.<sup>308</sup>

Leopold Cassella & Co. GmbH, Frankfurt a. M. (Cassella): In 1870 a plant of aniline dyes was founded by the chemists Dr. Leo Gans and August S. Leonhardt in Frankfurt-Fechenheim.<sup>309</sup> Sales were organized by the natural dye wholesale business of Leopold Cassella & Comp. of 1828 until the merger in 1894.<sup>310</sup> Although often mentioned, Cassella did not open a pharmaceutical department at the turn of the century. Arthur v. Weinberg<sup>311</sup> was a personal friend of the inventor of Salvarsan, Paul Ehrlich, but he suggested in January 1907 that Hoechst be encharged of the marketing of Ehrlich's organic compounds<sup>312</sup> Nevertheless Cassella carried out pharmaceutical research and supplied an external research institute, the Georg-Speyer-Haus, with raw materials.<sup>313</sup> In March 1907 contracts between the aforementioned research institution and Cassella and Hoechst (see below) were signed. The companies separated Paul Ehrlich's research areas: Hoechst worked on the organic arsenic compounds whereas Cassella concentrated on medical acridine-dyes.<sup>314</sup> This separation is clearly reflected by the patent allocation in the US.<sup>315</sup> A commercial activity in pharmaceuticals started in 1917 when an extensive study on the antiseptic properties of one of Cassella's acridine dyes had been published in GB.<sup>316</sup> This dye, Trypaflavin, was marketed as a pharmaceutical from 1918 on.<sup>317</sup> Large scale production of Trypaflavin started in Hoechst in 1919.<sup>318</sup> Other products quickly followed.<sup>319</sup> Cassella joined the Freia in 1919.<sup>320</sup>

<sup>307</sup> However BASF is said to have been constantly thinking about a comeback before 1903. Cf. Letter Duisberg to Brüning, 11.12.1903, reprinted in: *Dokumente aus Hoechster Archiven*, Vol. 9, p. 16.

<sup>308</sup> Vertrag zwischen BASF und E. Merck vom 10.03.1894, EMA R1/42, Abschnitt B; Cf. *Patentblatt* Nr. 15, 11. April 1894, Übertragungen.

<sup>309</sup> Vollmann, *Eigenständigkeit*, p. 60.

<sup>310</sup> To avoid complications with its traditional clientele the plant was first called Frankfurter Anilin-Farben-Fabrik Gans & Leonhardt and from 1879 on "Gans & Co." Vollmann, *Eigenständigkeit*, p.310.

<sup>311</sup> One of the directors and owners of Cassella. Gans, 'Zum 70. Geburtstag' p. 704; Hüntelmann, Paul Ehrlich 2011, S. 286f.; Ritter/Zerweck, 'A. v. Weinberg'.

<sup>312</sup> Arthur von Weinberg wrote Dr. v. Brüning (Hoechst) in January 1907 that he had proposed to market Ehrlich's discoveries at Hoechst, 'because we do not have a pharmaceutical department'. Letter A. v. Weinberg to Dr. v. Brüning, 07.01.1907, reprinted in *Dokumente aus Hoechster Archiven*, Vol. 14 (Vorarbeiten zum Salvarsan), p. 14.

<sup>313</sup> The Georg-Speyer-Haus in Frankfurt was directed by Paul Ehrlich, discoverer of the first syphilis cure, Salvarsan, marketed from December 1910 at Hoechst.

<sup>314</sup> Uebernahme der pharmazeutischen Produkte der Firma Cassella durch die Farbenfabriken Leverkusen, 28.12.1921, in: BAL 367-234. It is said that P. Ehrlich also preferred marketing Salvarsan at Cassella. Cf. *Dokumente aus Hoechster Archiven*, Vol.14, p. 94; Greiling, *Paul Ehrlich*, p. 129.

<sup>315</sup> Patents of the same discoverer, here: L. Benda (later Cassella's pharmaceutical director), had been assigned to Hoechst or Cassella depending on the research area; Acridine patent number 1005176 (Cassella), vs. arsenic patents numbers 1028101, 1036784, 1040260, 1075537 (Hoechst).

<sup>316</sup> Brochure: Trypaflavin. Ein Wundantiseptikum, überreicht von Leopold Cassella & Co., G.m.b.H, Frankfurt a.M., Juli 1917 (in possession of the author). An accompanying letter to the brochure states that the British highlighted the 'surprising value' of the dye and that it deserves attention and testing by the doctor because the authors had been supplied in 1913 with Cassella's original product.

<sup>317</sup> „Neue Arzneimittel“, in: Vierteljahrsschrift für praktische Pharmazie, 15 Jg., 2, 01.11.1918, p. 71ff. The German trademark was originally granted in 1910 for dyes (Nr. 136838). It was renewed the 22.04.1918 (Nr. 223689) for pharmaceutical purposes.

<sup>318</sup> *75 Jahre Arzneimittel Hoechst*, S. 33; Cassella did not balance any pharmaceutical sales in late 1916. Grundsätze für Bilanzierung und Inventarisierung I.G. 1916. Leopold Cassella & Co. G.m.b.H. in: HoechstA 6/ Roh Bilanz 1906-1911.

<sup>319</sup> Vollmann, *Eigenständigkeit*, p. 158f. E.g. 'Argoflavin', 'Panflavin-Pastillen', 'Tonophosphan'. Cf. Freia-Liste, SchA S1/006; „Neue Arzneimittel“, in: Vierteljahrsschrift für praktische Pharmazie, 16 Jg., 4 (31.12.1919), p. 167, 182; 17 Jg. (31.12.1920), p. 129.

<sup>320</sup> In 1922 Cassella's specialities were inscribed into the Freia list. In 1924 Cassella officially possessed a pharmaceutical department. Anonymous, 'L. Benda', p. 608; Speech Köbner, p.1, in: SchA B1-750/1; Freia list SchA S1/006; Letter Zimmer to Freia members, 13.12.1921, BAL 367-292.