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FZID discussion papers, No. 16-2010

Provided in cooperation with:
Universität Hohenheim



Suggested citation: Jopp, Tobias Alexander (2010) : The welfare state evolves: German Knappschaften, 1854 - 1923, FZID discussion papers, No. 16-2010, urn:nbn:de:bsz:100-opus-4761 , <http://hdl.handle.net/10419/33133>

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ISSN 1867-934X (Printausgabe)
ISSN 1868-0720 (Internetausgabe)

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"The Welfare State Evolves: German Knappschaften, 1854-1923"

by

Tobias Alexander Jopp*

Abstract

This paper reviews the German miners' model of mutual insurance from its introduction in 1854 to its basic reformation in 1923. Its core feature was the provision of cash benefits for compensation of income losses due to temporary sickness and permanent invalidity or death of the bread-winner. The carriers of the insurance scheme, the Knappschaften, date back to medieval times, and the Knappschaft is still present today as the second pillar of the German statutory old-age insurance. This paper aims to establish the Knappschaft insurance's main characteristics in the period under consideration. These include, for example, compulsory membership, shared financing between employed miners and entrepreneurs, self-management, financing based on earnings-related social insurance contributions, a strong emphasis of the insurance principle, and application of the pay-as-you-go mechanism. The organisational analysis is complemented quantitatively, on the one hand, by evidence on increasing generosity and, on the other hand, evidence on increasing financial distress substantiating the shadow side of a maturing pay-as-you-go based scheme. In particular, Knappschaften experienced all trends we commonly associate with today's systems in the second half of the 20th century as early as in the 19th century, even before the Bismarckian insurance was installed from 1883 on: Increasing social security spending, rising pensioners-to-contributors ratios, concentration and pressure on finances forcing Knappschaften to adjust their fiscal policy according to the mechanics of pay-as-you-go.

Keywords: Bismarck, mining, pay-as-you-go, social security, welfare state

JEL Classification: H55, N33, I38

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1 Introduction

This paper reviews the German miners' model of mutual insurance from its introduction in 1854 to its basic reformation in 1923.¹ Astonishingly, this model, which is one of the profession-specific origins of the Bismarckian-style social insurance and is thus inherent to some degree in every related social insurance system today, appears to be not that present in the English-speaking literature (Wagner-Braun, 2002: 28-32, Bartels et al., 2009: 200-208, Montz, 2010, and Sulzer, 2010).² For example, in his book "The Origin of the Welfare State in England and Germany, 1850-1914" Hennock (2007) mentions Knappschaften only briefly. In its introduction into the historical evolution of pension systems, "The Oxford Handbook of Pension and Retirement Income" (Thane, 2006, and Arza and Johnson, 2006) does emphasize the important role of the Bismarckian social legislation for today's schemes, but leaves the mining sector as some unspecified forerunner in the dark. Van der Linden (1996) deals with a wide range of mutual aid organizations like the friendly societies in Europe and abroad, but entails no information on Knappschaften. They, though membership was compulsory since absolutist times, originate in the idea of mutual, voluntary aid, and are in fact quite unknown in the literature. This essay ties to this gap and aims to give a condensed overview of how the welfare state evolved from the perspective of miners' insurance.³ Therefore, three questions are basically addressed: (1) What were the basic structural characteristics of this occupational scheme evolving since 1854? (2) How did the generosity of the system develop in quantitative terms? (3) Can we observe rising cost pressure while the Knappschaftens' pay-as-you-go system matured?

¹ In 1923, all existing German Knappschaften located in Prussia and the various other states merged into a single, empire-wide Knappschaft, the so-called Reichsknappschaft.

² Guilds, for example, have to be considered as well as risk provision institutions in the shipping and railway sectors.

³ However, there is literature explicitly on Knappschaften to be mentioned: A recent paper of Guinnane and Streb (2009) deals with ex post information asymmetries in the Knappschaftens' health insurance. An essay of Geyer (1992) briefly describes Knappschaft history from the 1850s to the 1960s.

The Knappschaft is an old institution. Even if the mode of operation has been subjected to changes over time, the scheme's main feature has not: the provision of cash benefits for compensation of income losses due to temporary sickness and permanent invalidity or death of the bread-winner. The carriers of the scheme, the so-called Knappschaften or Knappschaft organizations, date back to medieval times when fraternal associations of miners were first formed at around 1260. Still today, the Knappschaft is present as the second pillar of the German statutory old-age insurance. In 2005, the strictly occupational Bundesknappschaft merged with the Bahnversicherungsanstalt (social insurance for the railroad sector) and the Seekasse (health insurance for the shipping sector) into the Deutsche Rentenversicherung-Knappschaft-Bahn-See (German Pension Fund Knappschaft-Bahn-See) (Bartels et al., 2009, and Klenk, 2008: 125-126). The Knappschaft can thus look back at a continuous history of about 750 years.⁴

This paper is organized as follows. First, the Knappschaft institution's history from her beginnings to the Prussian mining reform, 1851-1865, is briefly described. In what follows then, I focus on Prussian Knappschaften. Although Knappschaften existed throughout the German territorial states (until 1870) and the German Reich (since 1871), this focus is justified for two reasons. Prussia was the core region of mining activity at the time and accounted for the vast majority of miners. Moreover, the legislation introduced in 1854 and amended several times since then was a child of the Prussian administration. The legislation then diffused relatively soon in almost all other German states (Karwehl, 1907: 20). Relating to question one and based on the legal fundament, the Knappschaft insurance's main characteristics are established, many of which soon diffused into Bismarckian social insurance as well. These characteristics include, for example, compulsory membership, shared financing between employed miners and entrepreneurs, self-management, financing based on earnings-

⁴ A trace not further pursued here focuses on similarities and differences with all kind of friendly societies and other miners' funds in Europe and abroad.

related social insurance contributions, a strong emphasis of the insurance principle, and application of the pay-as-you-go mechanism. Relating to question two, I will provide quantitative evidence on increasing generosity. Besides examining data on the number of funds and memberships, I draw especially upon expenditure data as well as analyze estimates of replacement rates. Finally, regarding the third question, evidence on increasing financial distress substantiates the shadow side of a maturing pay-as-you-go based scheme. Definitely, this has a parallel in the German social insurance's problems today. I therefore examine data on pensioners-to-contributors ratios and average pension durations as measures of (potential) financial distress.

In particular, I find that Knappschaften experienced all trends we commonly associate with today's systems in the second half of the 20th century as early as in the 19th century, even before the Bismarckian insurance was installed from 1883 on: Increasing social security spending, rising pensioners-to-contributors ratios, concentration and pressure on finances forcing Knappschaften to adjust their fiscal policy according to the mechanics of pay-as-you-go. This is to say that, by observing Knappschaften, we do not just learn more about a kind of distant, more or less alike, precursor of modern systems, but we gain direct insight into the origins of the long-term trends that threatens the (German) welfare state in its essence.

2 Historical Background

The German Knappschaften geographically originate in the medieval ore mining in the Harz Mountains (around Goslar) and Erz Mountains (Saxony). Verifiably since 1260, miners associated to brotherhoods with religious character aiming at maintaining customs, and eventually miners' tradition (Lauf, 2004: 115, and Bartels et al., 2009: 197). According to Lauf and in contrast to many 19th and early 20th century writers, associating activities had their source not in the very special conditions of mining at the time (and thus some kind of uniqueness), but followed the general trend of installing predominantly occupational brotherhoods (Lauf,

2003). In addition to fulfilling religious purposes, they aimed at supporting the members and their dependants with mutual aid both in the case of temporary and permanent income losses due to sickness, injuries, invalidity or even death of the bread-winner.

On a first developmental stage, contributions to the associations were voluntary and collected when they were needed, usually after an accident. Benefits in the sense of single payments were not high, but rather hardly had subsistence character. Moreover, benefits were not granted automatically, but according to the seriousness of need, i.e. case-by-case. With the Lutheran reformation, miners' associations lost their character as associations dedicated much to religious observance (Karwehl, 1907: 7, and Bartels et al., 2009: 197). Though, the idea of fraternal, mutual aid to compensate for income losses collectively existed further on. Miners' "social security" mutualism improved insofar as associations relatively soon installed regular contributions (*Büchsenpfennig*) to be paid by their members to build up permanent funds, even though resource-tested benefits dominated further on. Beyond that, the various regional mining codes enacted since the 13th century, showing the high fragmentation and the variants of mining legislation, also often specified that the proprietors of mines (*Gewerken*) had to share in the costs of sickness and invalidity claims. Hiltrop informs that they often had to pay replacement pay for sick miners up to 4 or 8 weeks while support pay for permanent disability was directly financed from the Knappschaftens' funds (Brassert, 1858, and Hiltrop, 1869, and Karwehl, 1907: 15-17). In particular, following Wagner-Braun (2002: 32-33), Knappschaft funds can be looked upon as the definite predecessors of statutory state insurance. The law of 1854, which will be soon reviewed, standardized mining-specific regulations at first within Prussia and introduced compulsory insurance for every miner.

On a second developmental stage, after the miners' Knappschaften had been incorporated into the absolutistic regime that emerged since about the middle of the 16th century, patronage by the sovereign was installed. Since it was a characteristic of the mercantilist state to administer the exploitation of natural resources in every respect, miners were, in fact, at the

royal administration's mercy (Kaufhold, 1994). For the emerging mining sector in Prussia several mining decrees enacted since the 1760s on behalf of Frederick the Great exemplarily show the encompassing control installed over mining. The so-called control principle (*Direktionsprinzip*) established direct state control over minerals' production and miners' work and privat sphere in general. Knappschaften as risk sharing communities were, by now, run by state representatives – in other words: they were obsolete as self-managing organisations. Basic benefits include, as before, support pay in the case of sickness and invalidity, and support for survivors. Although miners together with employers could not decide on their own on preferred income replacement rates and payments levels, employees had, anyway, received job-security until the Prussian mining reform (Bülow, 1905: 34-62, and Bartels et al., 2009: 198, and Tenfelde, 2004: 21).

3 The Legal Framework

The Knappschaft Law of 1854 and the Prussian General Mining Law of 1865

The developmental stage of relief by the sovereign and full state control over minerals extraction ended up in Prussia with the liberal reform of the mining law between 1851 and 1865 which replaced the control principle with the inspection principle (*Inspektionsprinzip*). Through several laws the state gave mine owners free-hand in all business-related decisions as, for example, determination of input and output quantities and wages, and stepped back into the position of an overseer (Brown, 1995, and Fischer, 1961a, and Fischer, 1961b). In particular, the reform brought about a new reporting instrument, the Prussian Knappschaft statistics. This comprehensive and frequently published statistical framework enables us to quantify aspects of Knappschaft business (e.g. stylized balance sheets) and to work out general tendencies (e.g. growth in size and average benefits) based on the entire population of organizations.

The Knappschaft law of 1854 and the Prussian general mining law of 1865 which finally bundled all reform laws enacted before formed the basic regulatory framework for the following decades. In particular, 1854 marks the true point in time when the social policy innovation “social insurance” was implemented based on legal claims, though with a strictly occupational scope compared to the Bismarckian insurance of 1883 to 1889. The latter eventually concentrated on a far broader base of workers (including miners). However, the state at the time definitely did not use 19th century Knappschaften to provide comprehensive redistribution, i.e. correction of the primary income distribution. Rather, as will become clear soon, the laws left some room for maneuver, e.g. with respect to monetary levels of benefits. Reviewing their business policy, in fact the result of mine owners’ and employed miners’ interaction in corporatist self-management, offers a directly member preferences-based perspective on the origin of the long-term increase in social security spending in Germany (and every related economy).⁵

Now the Knappschaft law is reviewed (Gesetz, 1854). In its first paragraph it states that Knappschaften had to be refounded in every area where mining and complementary economic activity like metallurgy took place.⁶ Aggregate coverage was thus undoubtedly rather small, and miners very probably privileged compared to members of related institutions.⁷ One can infer from this that future exploration activity and the number of existing mining areas would determine future entries of Knappschaften. Moreover, the paragraph highlights the types of organizations to distinguish. The area Knappschaft (*Bezirksknappschaft*) in the following became the predominant type, operating an insurance scheme for a limited number of miners contingent on the number and size of the mining enterprises located within its area. For the miners themselves, insurance was compulsory. The other type of organization was the

⁵ When it reads that the state did not use Knappschaften for redistributive purposes as the state does today, this is not to say that members themselves via self-management might not have expressed preferences for redistribution.

⁶ I refer to metallurgy as the “related industries”.

⁷ For an overview of such, see Hennock (2007). Especially guilds and (voluntary or compulsory) provident funds on the local level are to be mentioned here.

works-related one (*Werksknappschaft*) usually situated within the area of another Knappschaft and, because of the linkage to a single company, comparatively small. The resulting spatial distribution of Knappschaften somehow bears a resemblance with assigned territorial monopolies. Indeed, no Knappschaft could have had a subsidiary within the area of another one. Consequently, competition did not express in the free spatial movement of services by Knappschaften, but – if any – in the unrestricted spatial mobility of insurants. Further, the law specified life risks against which Knappschaften had to provide insurance coverage in the form of group insurance. These were the risks of sickness, invalidity and survivorship whereby both dimensions – the occupational and general risk – were covered.⁸ Related benefit categories included (1) non-monetary health care benefits like medical treatment and health resort attendance (usually provided for the family as well), (2) sick pay for every day on leave, (3) an invalidity pension until death, (4) funeral benefits, (5) a widow's pension until death or remarriage, and (6) and an orphan's pension until the age of 14. It was a characteristic of Knappschaften even before the reform to distinguish in miners with more rights and those with fewer rights in front of the Knappschaft. The so-called established miners (*Ständige*) could legally claim all categories whereby the unestablished miners (*Unständige*), usually day-labourers and the ones who did not qualify for established status although they worked permanently in the mining sector, could at first claim only (1), (2) and (4) (§3). Contemporaries presume that unestablished miners usually received benefits economically not equivalent to their contribution payments (Bertrams, 1912: 1459-1460). Moreover, paragraph 4 specified that Knappschaften could either levy a contribution as a fixed amount per contributor or as a percentage of labour income (both to be deducted at source by the employer, §11). We know from contemporary writers that Knappschaften predominantly levied a fixed amount, either the same for every contributor regardless of seniority or relative income positions, respectively, or graded by classes due to seniority and/or wages. Further receipt and expenditure

⁸ In fact, it seems rather difficult to attempt to distinguish between both analytically.

items were to specify by statutes (e.g. initiation fees, punishment fees or hospital operation, school education for the miners' children). Note that insured miners paid only one contribution to cover the various risks. In other words, sickness and pension insurance were not formally separated. Like the discrimination into established and unestablished members, shared financing between miners and mining entrepreneurs had a long tradition, too. The law itself prescribed a minimum (maximum) share of one third (one half) of total contributions to be paid by employers. Finally, the managing committee of a Knappschaft had to be filled on equal terms with representatives of miners and entrepreneurs. In the case a decision alternative was not in the majority, the representative of the mining administration had the decisive vote. It is a widespread feature of 19th century writings as well as of recent historical works to claim that entrepreneurs constantly had the relatively stronger influence in the self-management bodies since formal representatives of miners were usually friendlier to their bosses than to the ones they ought to represent. Those "median voters" – the elders (*Knappschaftsälteste*) – are said to have factually made the difference in favour of a stronger position of employers in self-management (Tenfelde, 2004: 26-33).⁹

The Prussian general mining law of 1865 included only few alterations (Klostermann, 1866). Unestablished miners could now claim an invalidity pension as well (§171). Beyond that, the mining law prescribed only a minimum – not an additional maximum – entrepreneur's share of one third of total contributions (hence, 50 percent of the miners' payments). Until 1906/07, the empirical shares had actually fluctuated between a mere 3 percent and roughly 95 percent of total contributions while the average share was predominantly around 40 to 45 percent.¹⁰ Finally, the law allowed a Knappschaft to divide their members into several smaller sickness funds while keeping a large pension fund. Following Guinnane and

⁹ An instruction manual to the law was published in 1855 substantiating on the one hand the typical outlay of a Knappschaft statute (which paragraphs should it have) and on the other hand the way how to determine per capita contributions (to be understood as a recommendation). In particular, the legislator made some considerations about the minimum efficient size of a Knappschaft; see Ministerium für Handel und Gewerbe (1854).

¹⁰ Ministerium für Handel und Gewerbe, *Statistik der Knappschaftsvereine des preussischen Staates* (Berlin, 1862-1908).

Streb, the idea behind was to improve cost control and to reduce moral hazard incentives in the sickness insurance, but to profit from the law of numbers regarding long-term liabilities like pensions (Guinnane and Streb, 2009: 7, and Jopp, 2010).

The initial laws of 1854 and 1865 lacked information on some other states of affairs. First, the laws did not establish elements of redistribution of revenues between prospering Knappschaften and those that suffered from an eroding contribution base due to demographic ageing and exhaustion of resource deposits. Actually, the only financial interconnections installed referred to spatial mobility of insurants. This mobility initially did not exist since miners willing to turn over to a firm in another mining area or even mining administration region would have lost their acquired entitlements. However, Knappschaften relatively soon engaged in concluding bilateral contracts called “reciprocity contracts” (*Gegenseitigkeitsverträge*) in order to regulate which Knappschaft had to settle what part of a miner’s entitlements when he had turned over. Second, the laws did not prescribe a financing mechanism explicitly. In fact, the mechanism applied could have been either pay-as-you-go, where current contributors directly finance expenditures on current beneficiaries (in particular pensioners) so as to balance the budget ex post at the end of a period, or funding, where each member or a generation of members accumulates contributions plus interest so as to finance retirement from that later on. The opinion of contemporaries, the instruction manual of 1855 and balance sheet information from the Knappschaft statistics strongly suggest that Knappschaften balanced their budgets via the pay-as-you-go mechanism (Caron, 1882: 7, and Bertrams, 1912: 1417). Third, the laws did not specify monetary levels of benefits, calculation principles or the relationship to contributions paid. Since not even monetary minimum standards or eligibility criteria were set, Knappschaften factually had much room for maneuver, and that explains most of the heterogeneity among them.

Sick pay, for example, was usually paid for the first eight weeks and then transformed into a (temporary) invalidity pension. Invalidity pensions predominantly consisted of a flat-

rate, varying in its level over Knappschaften and interpretable as a minimum pension, plus build-up rates for each contribution week, month or year during service. These rates depended on the classification of the miner according to his length of service and wage or occupation within the mine and varied as well over insurers. In particular, there is no hind at dynamic pensions. Rather, once granted pensions were principally not adjusted to any kind of economic dynamic (productivity, inflation).¹¹ In addition, each Knappschaft could decide about eligibility rules autonomously. However, the widespread criterion to qualify for an invalidity pension was simply the inability to work as a miner which was given if the miner could no longer earn one half of his actual wage. In contrast, the Bismarckian invalidity insurance granted pensions, if the employee was no longer able to earn one sixth of his average wage of the preceding five years and one sixth of the average wage in whatever job. The Knappschaftens' eligibility criteria can thus be labelled by and large as comparatively less strict (Frerich and Frey, 1993: 100). Survivors' pensions were usually specified as a proportion of invalidity pensions. Finally, as a result of the discrimination into established and unestablished insureds, Knappschaften inevitably set up criteria determining when an unestablished member qualified for established status. These criteria usually were a minimum age of between 16 and 25, a maximum age of between 35 to 45 years, good health, integrity and a successfully finished waiting period. In practice, later even miners permanently working in the mining sector were classified as unestablished in the case they did not meet the Knappschaft-specific criteria (Bertrams, 1912: 1459-1460).

Adjustments

Indeed, the laws of 1854 and 1865 specified the basic conditions under which Knappschaften operated until 1922. Nonetheless, these basic conditions were subject to adjustments. Two

¹¹ For Germany, the change from static to dynamic pensions is, of course, an achievement of the pension reform of 1957.

sorts of adjustments can be identified. First, those relating to improvements in the general economic legislation and those produced directly from constant critical dispute over institutional shortcomings of Knappschaften.

The employers' liabilities law of 1871 prescribed that an employer was responsible for employees in the case they experienced a job-related accident. If the employee was an insured miner, and the mining entrepreneur paid at least one-third of contributions, he could subtract the full amount of contributions linked to the miner from his damages (Guinnane and Streb, 2009: 7). Karwehl points out that many firms installed liability funds as a reaction to the law to pay out additional damages. In fact, the law did not prescribe to do so. Rather, the behaviour was due to a decree of the secretary of trade (Karwehl, 1907: 26-27). Bülow and Jordan, for example, claim that the liabilities law was of only minor importance for Knappschaften, unlike the accident insurance law of 1884 (Bülow, 1905: 34, and Jordan, 1905).

With Tampke (1982) we may say that the Bismarckian social legislation simply took over core characteristics of Knappschaften and made them available for a larger circle of workers of yet different occupations. However, the Bismarckian laws in turn affected Knappschaften as well. First, the health insurance law of 1883 dictated Knappschaften to raise daily sick pay to the standard set by the other sickness insurance funds, especially the works funds. Second, sick pay had to be granted from now on for thirteen weeks. Both adjustments led to considerable additional spending to be financed. Furthermore, the accident insurance law of 1884 installed employers' liability insurance associations for various occupations, so for miners, too. The newly-founded Knappschafts-Berufsgenossenschaft was responsible for paying pensions due to job-related accidents and was financed entirely by employers. This association had, though, principally nothing to do with the Knappschaften this paper deals with. Especially with respect to the Bismarckian invalidity and old age insurance, Knappschaft insurance and Bismarckian insurance have to be treated as two separate systems. A miner was definitely privileged in contrast to other employees since he could principally receive a Bis-

marckian pension and a Knappschaft pension. Relating to the law of 1889, there were, in all, three Knappschaften and an umbrella corporation which took over the Bismarckian invalidity insurance in addition to their own invalidity insurance as “special insurers” (*besondere Kasseneinrichtung*). All other Knappschaften acted from then on as “allowance funds” (*Zuschusskassen*).¹² The Bismarckian pension was now a miner’s main pension income. Knappschaften were said to reduce per capita benefits in absolute terms or to slow down relative benefit growth, respectively, as a consequence.

While the aforementioned laws made adjustments of the first sort necessary, the Knappschaft law of 1906 was the result of constant debate between Knappschaft officials, state representatives, researchers and miners themselves on failures and room for improvements (Steinbrink, 1908). In short, the key issues discussed since the late 1860s were (1) the appropriate Knappschaft size in the light of costs and benefits, (2) the institutional separation of the provision against the risks of invalidity and sickness, (3) the cost and benefits of the separation into established and unestablished miners, (4) reciprocity contracts to ensure free spatial mobility of miners without losing acquired entitlements, and (5) the adequate financing mechanism to ensure financial sustainability. Consequently, the law affected all those issues. First, it formally enabled the mining administration to merge small and/or financially unsound Knappschaften into larger ones or into those taken for financially stable, respectively. Second, it prescribed the formal institutional separation of both classes of insurance. From now on, both classes levied their own contribution payment. However, it is not clear to what extent the institutional separation really affected possibilities for cross-subsidization. Third, it removed the unestablished status. Fourth, the practice of bilateral reciprocity contracts was included into the legal framework, and the flat-rate pension was removed to synchronize the calculation basis across all Knappschaften. Pensions were thus made of variable

¹² These were the Allgemeine Knappschaft Bochum (Prussia: Dortmund), the Saarbrücker Knappschaft (Prussia: Bonn), the Allgemeine Knappschaftspensionskasse Sachsen (Saxony), and the Norddeutsche Knappschaftspensionskasse.

build-up rates exclusively. Fifth, the law forced a pay-as-you-go mechanism with intensified reserve-building (*Rentenwertumlageverfahren*) upon Knappschaften. Per capita contributions, then, had to be determined such that a) all pensions newly approved in period t_x were covered over their expected duration until $t_y > t_x$ and b) all pensions already approved before t_x were covered, with their respective value in t_x . Point b) corresponds, of course, to what Knappschaften already did before the amending law. Thus, many Knappschaften had to raise contributions considerably to meet the requirement. Further adjustments included the installment of shared financing on equal terms and sick pay for 26 weeks.¹³

4 A Quantitative View at the Prussian Knappschaften

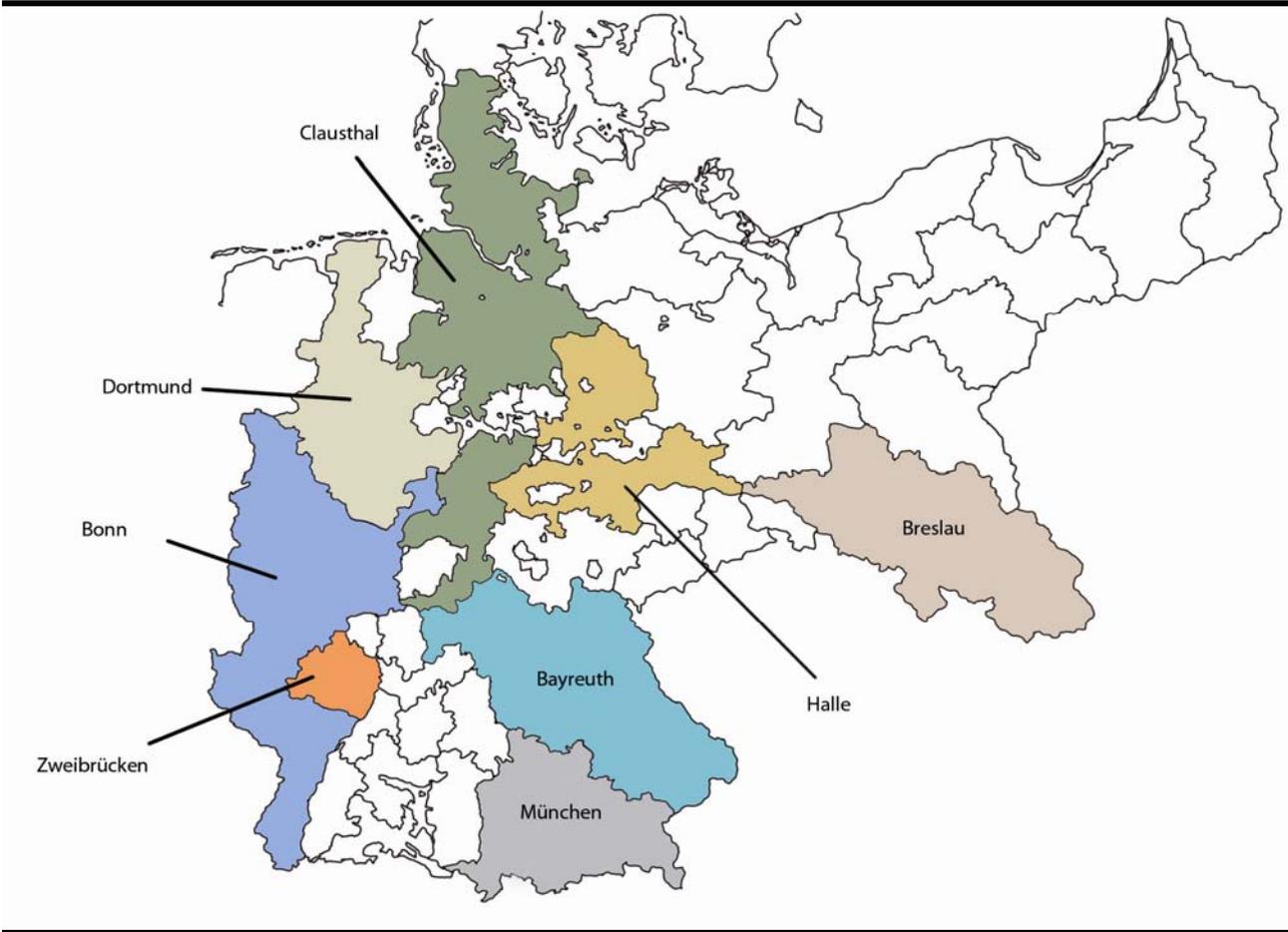
Number of Knappschaften, Regional Distribution and Size

After having briefly discussed the structural outlay of Knappschaft insurance, the quantitative part now follows. The main themes here are size, generosity and increasing cost pressure of a maturing insurance scheme consisting of a considerable number of pay-as-you-go financed plans (the Knappschaften). To begin with, Figure 1 locates the Prussian mining administration regions over which the Knappschaften in talk were distributed. According to the reorganization of the mining administration during the reform of 1851-1865, Prussia was subdivided into four mining administration regions each having their own administrative bodies. These were Bonn, Breslau, Dortmund and Halle. The fifth region, Clausthal, was formed due to territorial gains after the Prussian-Austrian war (relating to the province of Hannover). We can link mining administration regions with the production structure of the mining sector in Prussia. In terms of macroeconomic importance, hard coal stands out. Dortmund comprises the

¹³ In 1912, there was another Knappschaft reform accounting for the introduction of white-collar insurance in 1911. However, this paper exclusively deals with workers' insurance so that adjustment processes according to that law are not tackled here. Jopp (2010) in particular examines the relationship between Knappschaft size and actuarial risk of Knappschaften.

probably single most important European coal field at the time, the Ruhr coal fields, ever dominated by only few large Knappschaften. In the Breslau region, the important Lower and Upper Silesian coal fields were situated. The Saar coal fields were located in the Bonn region as well as the Aachen coal fields. With respect to brown coal, the Halle and Clausthal regions comprised the main areas (Saxonian fields and Harz fields). The ores, iron ore as well as other ores (copper, lead etc.), were predominantly extracted in the Bonn, Clausthal and Halle regions. Consequently, Knappschaften for related industries were situated there, too. Salt and stone extraction existed especially in Bonn, Dortmund and Halle.

Figure 1: Location of the Prussian and Bavarian Mining Administration Regions within the German Reich (at around 1871)



Notes: Bavarian mining administration regions (Bayreuth, München, Zweibrücken) are called *Berginspektionsbezirke* in German, the Prussian ones (Bonn, Breslau, Clausthal, Dortmund, Halle) *Oberbergamtsbezirke*.

Source: Bergamt Halle (1998): 29; Fürer (1988): 17; Oberbergamt Bonn, (1966): 22; Schelter (1992): 505-510; map constructed by Nolan Ritter (RWI).

The spatial distribution of these different types of natural resource deposits is a hind at the members' risk structure a Knappschaft had to work with. Even if I will not tackle this issue here further, we can reasonably assume that incidence rates regarding sickness, invalidity or death were relatively higher for hard coal mining than for any other extraction activities because of geological conditions surrounding extraction (especially depth). In all, the share of insurants employed in hard coal production increased from 55 percent in 1867 to 75 percent at the onset of war in 1913. This clearly has implications for aggregate as well as average claims costs.

Table 1: Number of German Knappschaften, 1861-1920

	Prussia					Bavaria			Other
	Bonn	Breslau	Clausthal	Dortmund	Halle	Bayreuth	München	Zwei- brücken	
1861	39	3	-	11	18	n.a.	n.a.	n.a.	n.a.
1866	43	4	-	11	19	n.a.	n.a.	n.a.	n.a.
1871	48	4	6	15	18	n.a.	n.a.	n.a.	n.a.
1876	46	4	9	15	13	n.a.	n.a.	n.a.	n.a.
1881	44	4	9	14	12	n.a.	n.a.	n.a.	n.a.
1886	42	3	4	14	12	9	19	11	51
1891	43	3	4	11	13	9	19	12	24
1896	43	3	4	10	13	9	19	13	18
1901	41	3	4	12	13	9	19	13	23
1906	41	3	4	11	13	9	9	10	26
1911	37	3	4	10	11	9	9	10	27
1916	30	3	4	10	9	8	8	10	n.a.
1920	20	3	4	9	8	n.a.	n.a.	n.a.	n.a.

Notes: Shown are mining administration regions; "n.a." is "not available"; "other" includes the Kingdom of Saxony, the Kingdom of Wurttemberg, the grand duchy of Hesse, the gran duchy of Brunswick, the duchy of Anhalt, the duchy of Sachsen-Altenburg, the duchy of Sachsen-Meiningen, the principality of Waldeck, the principality of Schwarzburg and Alsace-Lorraine.

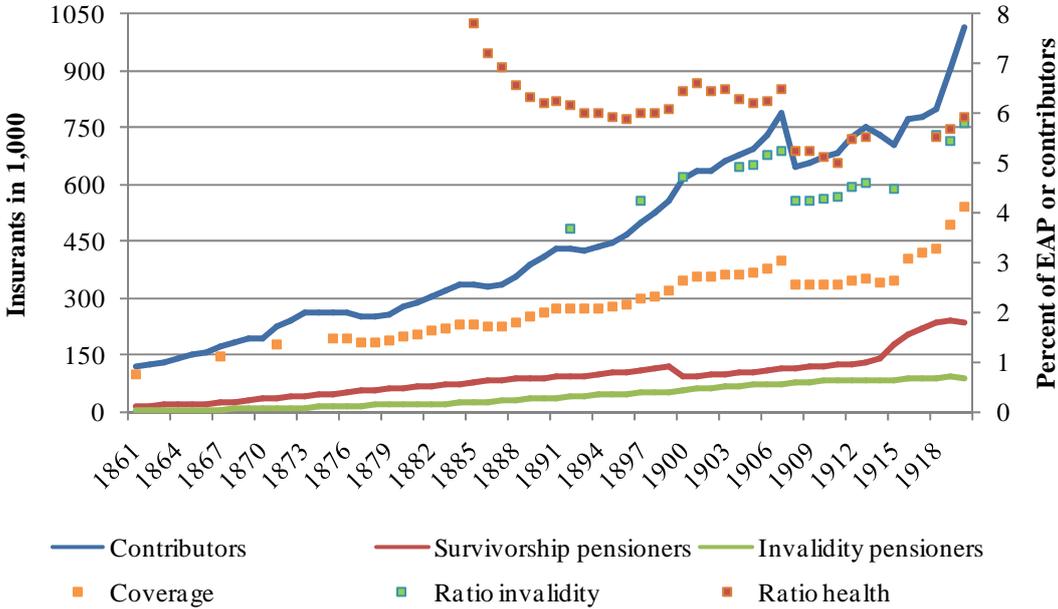
Source: Ministerium für Handel und Gewerbe (1862-1920); Königreich Bayern (1884-1920); Karwehl (1907); Simons (1895); Imbusch (1910); Köhne (1911).

Table 1 shows the annual number of all German Knappschaften over the years 1861 to 1920. There remains some uncertainty about the number of Knappschaften subsumed under the item “other” since official statistics, unlike for Prussia and Bavaria, are not at hand for the remaining German states. Rather we have to rely on information from secondary 19th century sources which is fairly scarce. Prussia constantly accounted for about the half of organizations and about 90 percent of all miners. Prussian Knappschaften themselves were relatively unequally distributed among mining administration regions. While the Bonn region was highly fragmented, miners in the Breslau region were distributed across few Knappschaften. In 1861, seven years after the enactment of the pathbreaking Knappschaft law, 71 Knappschaften were in operation. This number increased to a remarkable 91 in 1870/1871. Insurers consolidated thereafter in four phases, 1872 to 1885, 1886 to 1906, 1907 to 1916, and 1917 to 1920 (or 1923 if one takes the implementation of the Reichsknappschaft into account). The second of these phases was one of relative stability, but all other phases exhibited an obvious declining trend in the number of insurers. More than this, the pace and intensity of consolidation enhanced since 1907 and especially in the course of World War I.

Beyond that, Figure 2 highlights that, while the number of Prussian Knappschaften decreased by 52 percent from 1871 to 1920, the number of insurants as a whole – that is, contributors and pensioners together – increased by 387.6 percent from 275,143 to 1,341,567 (contributors by 347 percent, pensioners by 577.6 percent). This important trend points directly to the fact that the average Knappschaft had grown larger and larger. In contrast, though, the median Knappschaft size, which is the size of the organization that separates the number of Knappschaften in one year in two equally sized fractions after sorting by size, was relatively stable. The former increased from 1,675 contributors in 1861 to about 13,809 in 1916 (724.4 percent!), whereas the latter “only” grew by 289 percent in that period, from 449 to 1,747 contributors. Besides, the level of median Knappschaft size was obviously much lower, indicating that most organizations were smaller ones. In addition, Figure 2 compares

the coverage of Knappschaften to the coverage of Bismarckian social insurance. While the Knappschaftens' coverage in terms of the economically active population rose from about 1 to 4 percent, the coverage of Bismarckian health insurance rose from about 21 percent after implementation in 1883 to 44 in 1913, clearly at a higher pace. Coverage of Bismarckian invalidity insurance initially was about 49 percent and remained quite stable towards 1913.

Figure 2: Aggregate Membership and Coverage of Prussian Knappschaften, 1861-1920



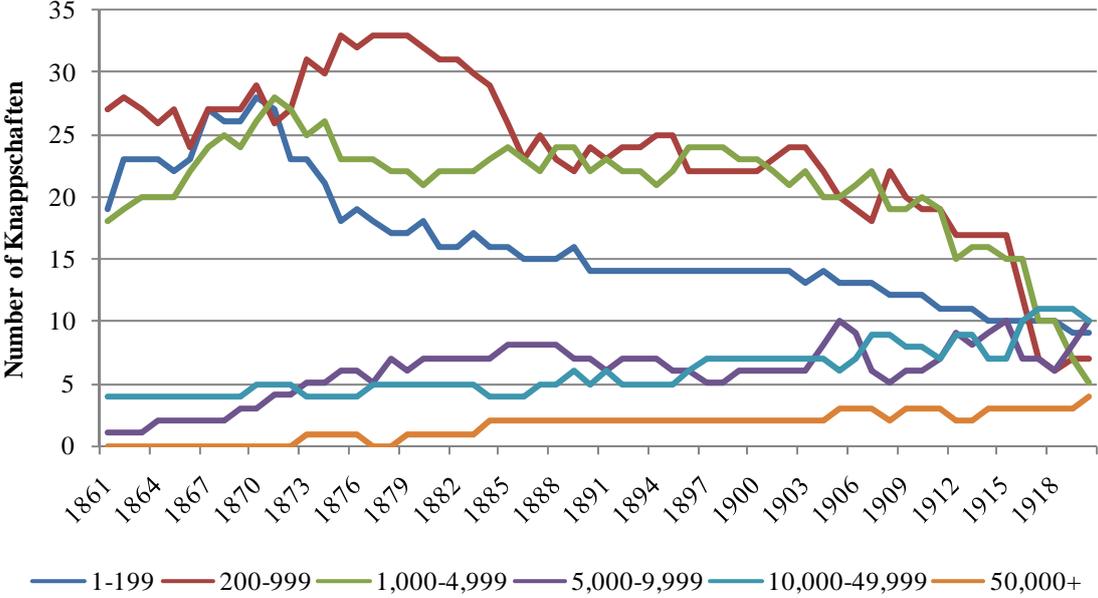
Notes: Contributors include established (ständig) and unestablished (unständig) members; survivorship pensioners include widows and orphans. Coverage is contributors plus invalidity pensioners divided by the economically active population (EAP). Ratio invalidity (ratio health) is contributing miners divided by contributors of Bismarckian invalidity and old age insurance (health insurance).

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922); Hoffmann (1965): 172-174; Sommariva and Tullio (1987): 235. Khoudour-Castéras (2008); Frerich and Frey (1993): 102.

Furthermore, Figure 3 displays the absolute frequency of Knappschaft size in the observation period. Knappschaft size is measured in terms of contributing miners (established plus unestablished ones). The displayed distribution among size classes indicates again that actu-

ally more Knappschaften were smaller than larger.¹⁴ To be precise, the first three classes from 1 to 4,999 contributors always accounted for more than fifty percent of insurers – except for 1918 to 1920. Moreover, the relative frequency of small Knappschaften sized between 1 and 199 (1 to 499) contributors never fell short of 18 percent (30 percent). Towards 1920, nevertheless, the three largest size classes became gradually more important. The three largest insurers in 1920, the Allgemeine Knappschaft Bochum (Ruhr coal fields), the Oberschlesische Knappschaft (Upper Silesian coal fields) and the Saarbrücker Knappschaft (Saar coal fields) had approximately 412,000, 178,000 and 64,000 contributors.

Figure 3: Absolute Frequency of Knappschaft Size, Prussia, 1861-1920



Notes: Size is measured by the number of contributors (established plus unestablished ones).

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922)

Thus, reviewing the structural developments in Prussia in more detail, one can reasonably say that some Knappschaften grew large, by a combination of internal and external growth or by

¹⁴ The frequency distribution displayed here is relatively robust against inclusion of pensioners since class intervals are not that narrow.

internal growth solely, and many remained rather small. Consequently, Knappschaften appear to have participated very unequal in the economic growth of the mining sector at the time. Note that the production of Prussia's single most important mining product hard coal grew rapidly from about 11.8 million tons (1861) to 180.1 million tons (1913), hence by 1,426.3 percent.¹⁵ Though, most Knappschaften that insured miners working in the hard coal subsector had already belonged to the larger ones in 1861. Other subsectors, for example most ores, underwent a far more volatile production profile.¹⁶

Looking at the long-term growth performance of Knappschaften in more detail reveals the following. Of 103 observed Knappschaften, 41 exhibited a negative average annual growth rate during their whole operation within the time interval 1861 to 1920. In addition, 7 grew on average between 0 and 1 percent per year, 44 between 1 and 5 percent. 10 grew by more than 5 percent per year, thereof only four organizations, operating for a minimum of 53 years. In fact, about one quarter of the Knappschaften facing a long-term shrinking process disappeared by dissolution before 1920, another two quarters disappeared by merging with another one. In all, 47 out of 103 Prussian Knappschaften were involved in 20 mergers the Prussian Knappschaft statistics explicitly mentions (1869-1916), thereof 15 mergers by absorption and 5 refoundations. With respect to size, one can observe that the absorbing Knappschaft was always larger than the absorbed one(s). The size differentials were occasionally substantial. Moreover, absorbed Knappschaften had, on average, the higher pensioners-to-contributors ratios (up to about 90 pensioners per 100 contributors!). That gives a clear indication of the financial pressure they had to bear because of an ageing collective (see below).

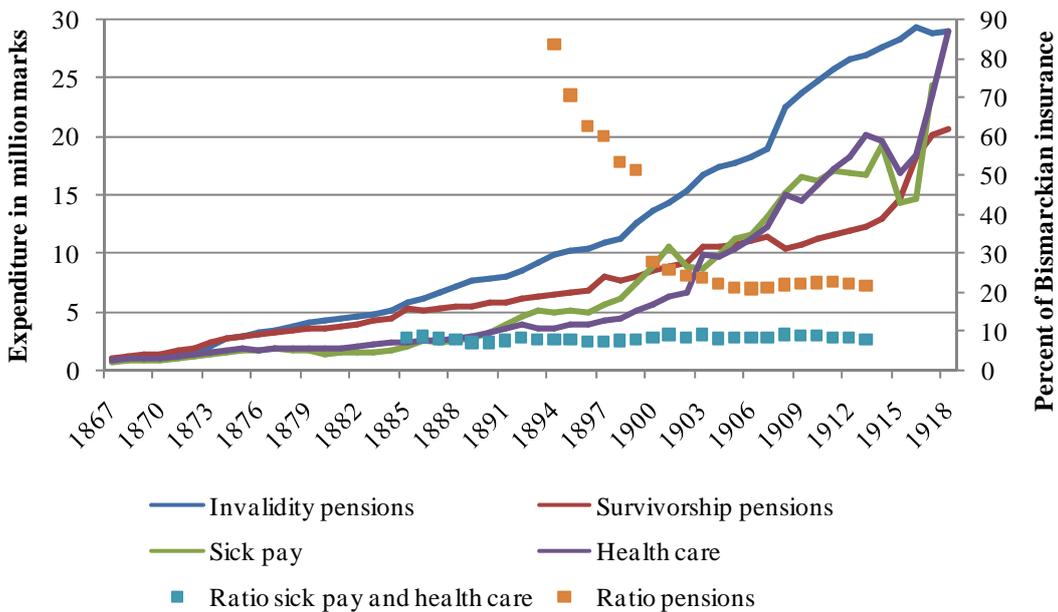
¹⁵ Prussia's hard coal production accounted for 83 percent of the German production in 1861 and for 95 percent at the onset of World War I.

¹⁶ In a yet unpublished working paper I examine the relationship between a Knappschaft insurer's size and his exposure to actuarial risk. I therefore built a model much in the style of Emery and Emery (1999). Preliminary results suggest that actuarial risk in terms of the variance of the average claim or, alternatively, in terms of the ruin probability was optimally reduced after having reached a size of about 5,000 contributors (with respect to the variance) or 10,000 contributors (with respect to ruin probability).

Generosity

Commonly known, public spending on social security, in general, increased not only for Germany from the mid-19th century on. On a smaller scale than Bismarckian insurance regarding coverage, Knappschaften were the forerunners in expanding generosity of insurance benefits reflecting thereby pure members’ preferences towards a certain income replacement standard. This subsection therefore presents data on the Knappschaftens’ comparative generosity during the formative period of social insurance. I briefly compare these data from the Prussian Knappschaft statistics – not individual statutes – with the younger, but more extensive Bismarckian scheme. Using data from the Knappschaft statistics inevitably allows only for statements “on average”. Clearly, the analysis can thus not capture all peculiarities among Knappschaften.

Figure 4: Aggregate Nominal Expenditure of Prussian Knappschaften for Pensions, Sick Pay and Health Care, 1867-1918



Notes: Ratio pensions is the sum of invalidity and survivorship pension expenditure of Knappschaften divided by the sum of invalidity and old age pension expenditure of Bismarckian social insurance; ratio sick pay and health care is the sum of sick pay and health care expenditures of Knappschaften divided by health expenditures of

Bismarckian health insurance; the value of sick pay expenditure for 1918 is dropped (52 million); the first three values of ratio pensions are dropped because of their magnitude (1891: 1,076, 1892:562, 1893: 381).

Source: Own illustration based on Ministerium für Handel und Gewerbe (1962-1922); Khoudour-Castéras (2008).

First of all, Figure 4 illustrates the development of aggregate nominal expenditures of Knappschaften on benefit categories. Other expenditures, e.g. for administrative purposes, are neglected here since their magnitude was widely relatively low. As can be seen, aggregate expenditures on invalidity pensions increased from about 2 million marks in 1867 to nearly 29 million marks in 1918, and were thus the single most-important benefit item.¹⁷ The ratio of expenditures on sick pay and health care of Knappschaften to those of Bismarckian insurance constantly amounted to between 7 and 8.5 percent while the ratio of pension expenditure decreased from more than 1,000 percent (!) at the start of public pension insurance to still remarkable 20 percent in 1913. This point is worth noting insofar as Figure 2 indicates that Knappschaften disposed of only 5 to 8 percent of the Bismarckian invalidity insurance's contributors. This implies in general an overproportionally higher financing burden on one contributing miner than on the average Bismarckian insurance's member. This burden still remains if we take into account that miners' average wages were higher than workers' average wages on the whole.

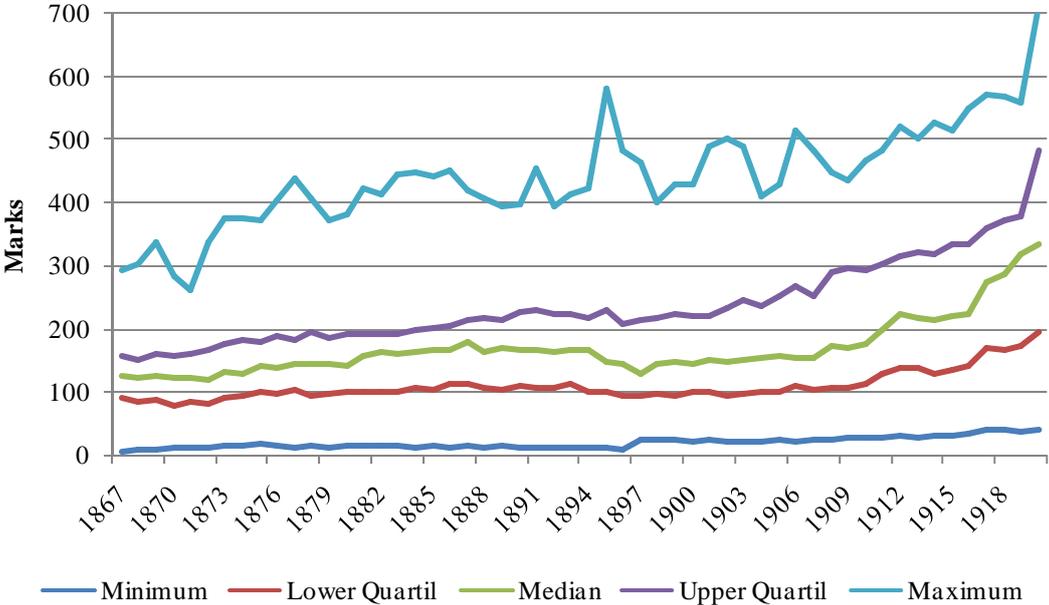
Figures 5 and 6 detail the picture by providing descriptive statistics on the two single-most important Knappschaft insurance benefits, the average annual invalidity pension and daily sick pay. Data on all 103 Prussian Knappschaften operating in the observation period firstly highlight the heterogeneity among them with respect to monetary levels. The range between minimum and maximum average annual invalidity pension increased from about 280 to more than 500 marks. Hence, some Knappschaften increased their nominal generosity

¹⁷ With respect to all monetary data, I dropped the years of open inflation.

much more than others. Furthermore, the median pension which does not deviate much from the arithmetic mean initially amounted to 120 marks and rose to over 300 marks. Moreover, the mean daily sick pay increased from 0.60 marks to more than 2 marks. On the whole, however, the descriptive statistics imply that both average benefits were raised considerably only since the early 20th century.

For information, average widows' and orphans' pensions can be expressed as a percentage of average invalidity pensions. Empirical evidence suggests that those items predominately lay between 50 to 60 percent and 10 to 15 percent, respectively. Important here is the point that public survivors' provision was introduced as early as in 1911 empire-wide, along with white-collar insurance. Knappschaften evidently put this welfare enhancing activity much earlier on their agenda.

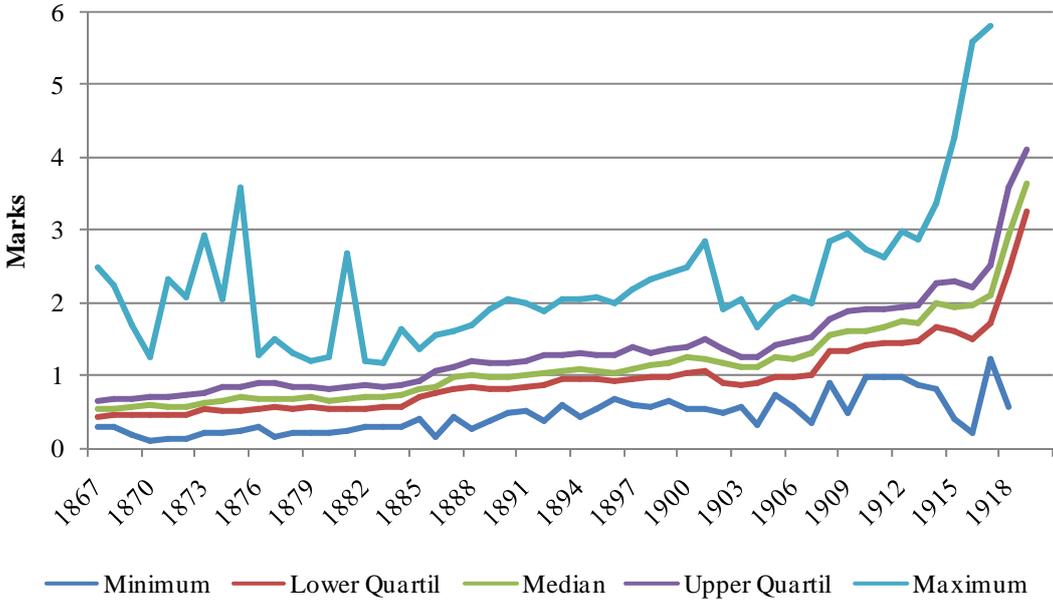
Figure 5: Per Capita Annual Invalidity Pension of Prussian Knappschaften, 1867-1920



Notes: Per capita invalidity pension is the unweighted arithmetic mean per Knappschaft and year.

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922).

Figure 6: Sick Pay per Sick Day of Prussian Knappschaften, 1867-1920



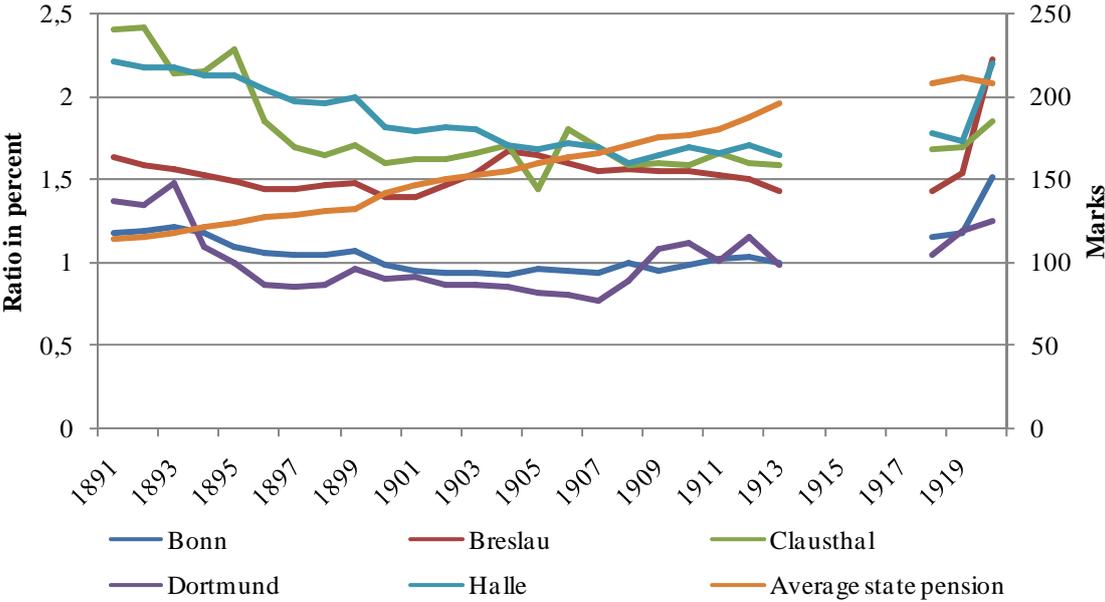
Notes: Sick pay per sick day is the unweighted arithmetic mean per Knappschaft and year

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922).

Data on Bismarckian health insurance expenditures reported by Frerich and Frey suggest a sick pay per sick day of about 1.04 marks in 1885 and 1.44 marks in 1910 which is at first more than the upper quartile of the Knappschaftens' sick pay, but later less than median sick pay. It was mentioned above that the introduction of state health insurance forced almost all Knappschaften to adjust their sick pay benefit upwards to meet legal requirements. Looking at the data we can confirm there was indeed a gap in favour of Bismarckian insurance in 1885. However, while state daily sick pay was raised at 38.5 percent when mean sick days per insurant increased by 36.4 percent (from 5.96 in 1885 to 8.13 in 1910), Knappschaft daily sick pay on Prussian average doubled when mean sick days per miner increased as well, but at a lower rate (from 6.7 in 1885 to 7.3 in 1910) (Frerich and Frey, 1993: 102). That Knappschaften could obviously expand their generosity comparatively more, may have been due to successful efforts to keeping moral hazard-induced sick days as low as possible (Guinnane and Streb, 2009). What about a comparison of average invalidity pensions? Figure 7 therefore

shows the ratio of mining administration region-specific average pensions to the Bismarckian pension. I chose to focus on mining administration regions here since wage data on those regions point to spatial wage differentials. Except for Bonn and Dortmund for some time, Knappschaft pensions were higher than the Bismarckian average pension in absolute terms – about 50 percent at least –, but obviously relatively decreasing or at least stagnating in terms of long-term growth. The absolute value of the annual Bismarckian pension is displayed on the right axis. It amounted to about 115 marks at first and to about 210 marks towards 1920.

Figure 7: Ratio of the Knappschaftens’ Average Annual Invalidity Pension by Mining Administration Region to Bismarckian Average Annual Invalidity Pension, 1891-1920



Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922) and Khoudour-Castéras (2008).

Since size and consequently growth patterns were a main source of heterogeneity among Knappschaften, as has been shown above, Tables 2 and 3 present additional data on average benefits by Knappschaft size. In general, average benefits increased over time and with size. With respect to pensions, small Knappschaften sized between 1 and 999 contributors raised

their average benefit not as high as larger ones implying that members of smaller organizations were comparatively worse off. However, as mentioned above, wage differentials have to be taken into account. Though, we may carefully say that larger Knappschaften granted relatively higher benefits than smaller ones.¹⁸

Table 2: Average Invalidity Pension by Size Class in Marks, 1867-1918 (Index 1908-1913=100)

	1-199	200-999	1,000-4,999	5,000-9,999	10,000-49,999	50,000+
1867-1871	131 (78)	119 (76)	119 (50)	125 (56)	159 (57)	-
1872-1876	125 (74)	134 (86)	140 (59)	157 (70)	203 (73)	-
1877-1881	127 (76)	138 (89)	164 (69)	172 (77)	220 (80)	225 (70)
1882-1886	128 (76)	143 (92)	179 (75)	179 (80)	229 (83)	239 (75)
1887-1891	133 (79)	158 (101)	177 (74)	161 (72)	261 (95)	215 (67)
1892-1896	144 (86)	154 (99)	169 (71)	163 (73)	290 (105)	200 (63)
1897-1901	131 (78)	149 (95)	170 (71)	127 (56)	282 (102)	206 (65)
1902-1906	148 (88)	147 (94)	192 (81)	167 (75)	263 (95)	250 (78)
1908-1913	168 (100)	156 (100)	238 (100)	224 (100)	276 (100)	320 (100)
1914-1918	168 (100)	191 (122)	297 (125)	302 (135)	282 (102)	345 (108)

Notes: see Figure 5.

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922).

Table 3: Average Daily Sick Pay by Size Class in Marks, 1867-1918 (Index 1908-1913=100)

	1-199	200-999	1,000-4,999	5,000-9,999	10,000-49,999	50,000+
1867-1871	0,53 (43)	0,56 (38)	0,57 (33)	0,60 (30)	0,73 (39)	-
1872-1876	0,62 (50)	0,62 (42)	0,69 (40)	0,75 (37)	0,89 (48)	1,03 (55)
1877-1881	0,57 (46)	0,63 (42)	0,73 (43)	0,84 (41)	0,92 (49)	0,98 (52)
1882-1886	0,60 (49)	0,69 (46)	0,82 (48)	0,85 (42)	0,91 (49)	0,93 (50)
1887-1891	0,76 (61)	0,94 (63)	1,11 (65)	0,97 (48)	1,19 (64)	1,07 (57)
1892-1896	0,83 (67)	1,01 (68)	1,19 (70)	1,05 (52)	1,26 (67)	1,33 (71)
1897-1901	0,87 (70)	1,10 (74)	1,26 (74)	1,20 (59)	1,31 (70)	1,58 (85)
1902-1906	0,67 (55)	0,97 (65)	1,12 (66)	1,35 (67)	1,33 (71)	1,15 (62)
1908-1913	1,24 (100)	1,48 (100)	1,71 (100)	2,02 (100)	1,86 (100)	1,87 (100)
1914-1918	1,66 (135)	1,86 (125)	2,14 (126)	2,66 (132)	2,57 (138)	2,39 (128)

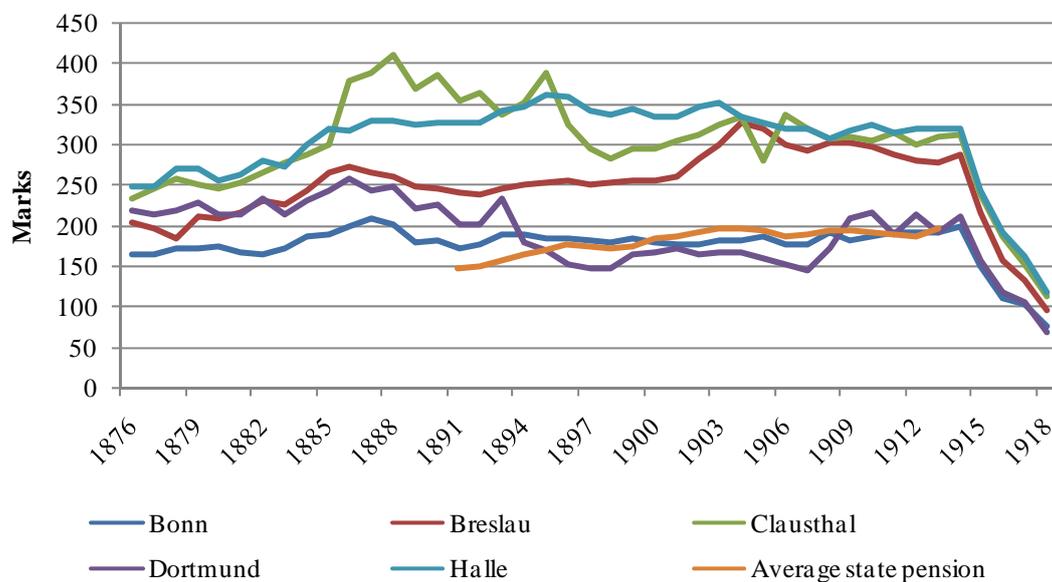
Notes: See Figure 5.

¹⁸ Average contribution payments by members of Prussian provident funds (*Gewerbliche Unterstützungskassen*) for 1864-1874 suggest that average support pay by far did not match the magnitude of the Knappschaftens' average benefits. For 1864, Frerich and Frey report an average contribution over nearly 3,000 funds of 7.64 marks, raised to 11.25 marks in 1874 (4,877 funds). These figures include a persistent 20-22 percent share of employers. Comparatively, the corresponding average contribution payments with respect to the entire Knappschaft population were 25.3 and 37.3 marks.

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922).

Further, taking consumer prices into account, the Bismarckian real average pension increased from 150 to 200 marks from 1891 to 1913 while real Knappschaft pensions by administration region grew predominantly towards the implementation of the Bismarckian invalidity insurance, but stagnated or decreased thereafter.

Figure 8: Real Average Invalidity Pension by Mining Administration Region and Average Bismarckian Pension, 1876-1918



Notes: Values of the consumer price index for 1916 (180), 1917 (225) and 1918 (310) were dropped.

Source: Own illustration based on Ministerium für Handel und Gewerbe (1862-1922); Deutsche Bundesbank (1976).

Probably more informative than absolute pensions or sick pay in marks is the income replacement rate. Regarding pensions, I simply compute the ratio of the average pension in period t to the average annual wage for the respective region in t in which the Knappschaft was situated and for the subsector in which most insurants were employed. We can carefully interpret this ratio, formally the net pension level in year t , as the income replacement rate of the

first received pension payment to the last earned net wage. In fact, the data show that pensions replaced predominantly 20 or more percent of net wage, and replacement increased towards 1891. After the public invalidity insurance was introduced, Knappschaften obviously used their room for maneuver to cut replacement. From a cross-sectional view, the data also suggest that replacement increased with size. Sick pay replacement is rather low compared to what contemporary writers usually stated (50 or more percent on average). A comparison of income replacement by the average invalidity pension leads to the conclusion that Knappschaften guaranteed a higher replacement on average, even after 1891. Following Frey and Frerich, the Bismarckian pension replaced about 16 to 17 percent of gross labour income. Note again that I display data on net replacement. In fact, net replacement rates do not decrease by more than 2 to 3 percent if we took social insurance contributions into account. Especially, the pension income replacement of the three largest Knappschaften per each year – these were always the same: the Allgemeine Knappschaft Bochum and its direct predecessors, the Oberschlesische Knappschaft and the Saarbrücker Knappschaft – usually exceeded 28 percent. These Knappschaften alone covered between 54 percent (equals 113,000) and 67 percent (equals 886,000) of all insured individuals (active miners, invalids and survivors) between 1867 and 1920.

The presented income replacement rate estimates are definitely not comparable to rates many present day schemes, especially in the developed countries, provide. With respect to pensions in particular, this is explainable by fact that the concept of an individual's lifetime as split into three stages – youth, employment, and retirement – had not broken through, even not really with Bismarckian old age insurance. So, 19th and early 20th century contemporaries may not have identified a pension as self-standing retirement income.

Table 4: Estimates of Invalidity Pension and Sick Pay Replacement Rates by Size Class, 1867-1918

	1-199		200-999		1,000-4,999		5,000-9,999		10,000-49,999		50,000+	
	IP	SP	IP	SP	IP	SP	IP	SP	IP	SP	IP	SP
1867-1871	21.3	28.0	21.0	30.2	19.1	25.8	20.7	29.4	23.3	31.9	-	-
1872-1876	16.8	21.7	19.0	26.0	17.6	24.8	18.3	26.0	25.4	31.8	25.2	31.4
1877-1881	19.2	24.7	24.1	32.1	24.6	36.5	22.6	38.6	35.3	44.6	30.4	40.7
1882-1886	21.4	28.3	22.0	31.2	27.7	36.5	22.7	35.2	32.0	40.2	31.5	38.6
1887-1891	20.8	31.6	22.4	38.8	27.4	45.4	22.3	39.9	31.1	46.8	28.4	38.5
1892-1896	21.0	37.0	22.2	42.0	25.5	48.6	22.2	42.2	34.0	46.8	24.3	44.6
1897-1901	16.8	34.7	17.3	36.0	21.0	40.0	13.5	37.4	31.0	44.8	21.4	43.8
1902-1906	20.4	29.3	16.9	33.5	23.6	35.2	17.6	39.6	28.2	42.0	25.7	31.7
1908-1913	26.4	43.7	14.3	39.3	23.2	42.7	18.6	49.0	26.9	51.7	24.8	44.0
1914-1918	-	-	11.9	34.0	20.0	40.7	16.1	42.4	19.2	45.0	17.8	38.3

Notes: IP denotes per capita invalidity pension, SP sick pay per sick day. Net pension replacement in period t is per capita pension divided by mean annual net wage. Net sick pay replacement in period t is sick pay per sick day divided by mean annual net shift earnings. Annual wages and shift earnings refer to the mining administration region in which the respective Knappschaft is located, and the subsector in which a Knappschaft's insureds were mainly employed. Wages were extrapolated backwards from 1883 for all mining administration regions but Dortmund using the arithmetic mean of the ratio of a mining administration region's wages to wages in Dortmund for 1884 to 1913.

Source: Own calculation based on Ministerium für Handel und Gewerbe (1862-1922); Ministerium für Handel und Gewerbe (1885-1922), statistical part, for wage data of 1884 to 1920; Holtfreich (1973): 54-56.

To summarize the development, Knappschaften pursued different strategies with respect to expansion of per capita generosity and due to their respective perceived growth paths. However, data point to widespread expansion of the Knappschaftens' generosity that might have, in addition, even outnumbered the expansion of generosity in the Bismarckian scheme.

Demographic challenges and financial (in-)stability

This subsection finally establishes three stylized facts on the shadow side of a maturing – we may alternatively say: ageing – PAYGO financed pension scheme. The first fact refers to a variable of significant matter for every such scheme, namely the pensioners-to-contributors

ratio (PCR). Recall, on the one hand, that in a PAYGO system current contributors finance expenditures on current beneficiaries and that, on the other hand, the budget is formally balanced at the end of each period. Mechanically, the contribution rate additively depends on three factors: a) the PCR, b) the gross pension level (ratio of average pensions to average wage), and c) the fraction of state subsidies expanding the receipt base (Schmähl, 2001). We may treat a rising PCR as an exogenous demographic or structural shock, respectively, to a Knappschaft.¹⁹ Since Knappschaften neither received state subsidies, nor supported each other with financial aid in the case of crisis, they could principally react to rising PCRs by adjusting contributions per capita upwards or average pension benefits downwards.²⁰ A third possibility not mentioned above was to draw on reserves created in the past in order to keep contributions and benefit levels constant. In fact, per capita reserves were for most Knappschaften rather small so that they could have possibly smoothed out seasonal or cyclical fluctuations, but they did not represent funds sufficient to cover acquired entitlements of contributors and pensioners over expected average pension durations, at least not before 1906.

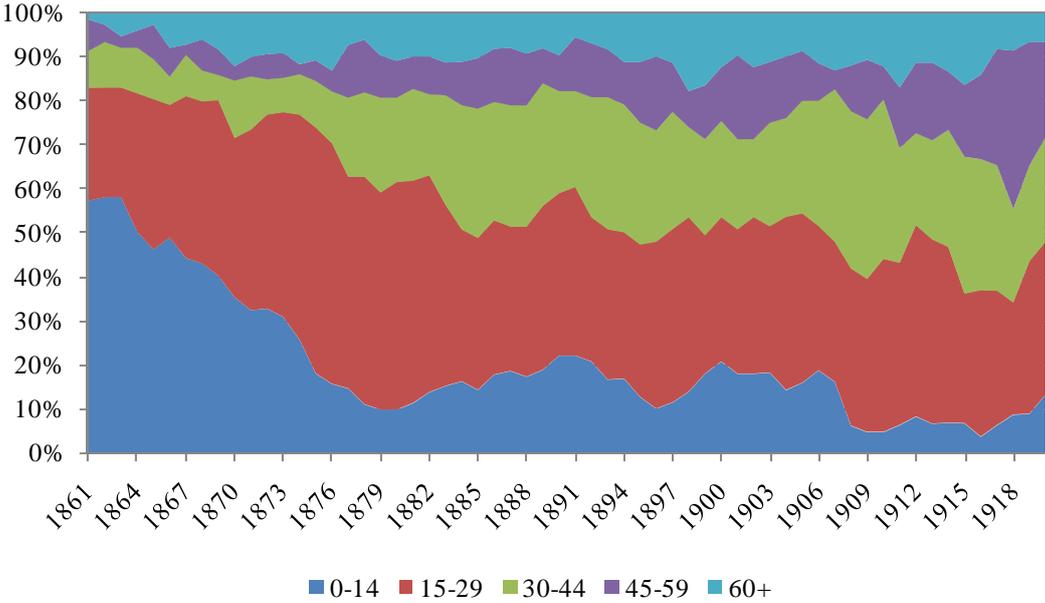
Figures 9 and 10 illustrate the great demographic-structural challenge Knappschaften faced while maturing. The former displays the proportion of Knappschaften that experienced a PCR of 14 or less pensioners per 100 contributors and so forth. Impressively, the relative frequency of Knappschaften having no more than 14 pensioners per 100 contributors decreased from about 58 percent in 1861 to between 10 and 25 percent during 1879 to 1907 and 5 to 10 percent thereafter. Further on, the proportion of Knappschaften facing a PCR of above 30 was initially 18 percent and finally about 50 to 55 percent. Note that, for example, the German system today faces a PCR of about 25 to 35 and expected to rise further in the future.

¹⁹ Strictly speaking, a Knappschaft could – as a social insurer today – impact on the entries of pensioners by sharpening eligibility rules. This is to say the PCR is at least in part endogenous, so home-made.

²⁰ Strictly speaking, wages are in part endogenous, too, since employers participated in self-management and at the same time set wages. However, there is no kind of anecdote in the literature that employers adjusted mining wages directly intending to cut the gross pension level. So, we may refer to wages in this setting as exogenous, too.

In particular, the range of PCR values is much higher than today. There were Knappschaften experiencing 80 or more pensioners per 100 contributors!

Figure 9: Relative Frequency of Pensioners-to-Contributors Ratios of Prussian Knappschaften, 1861-1920

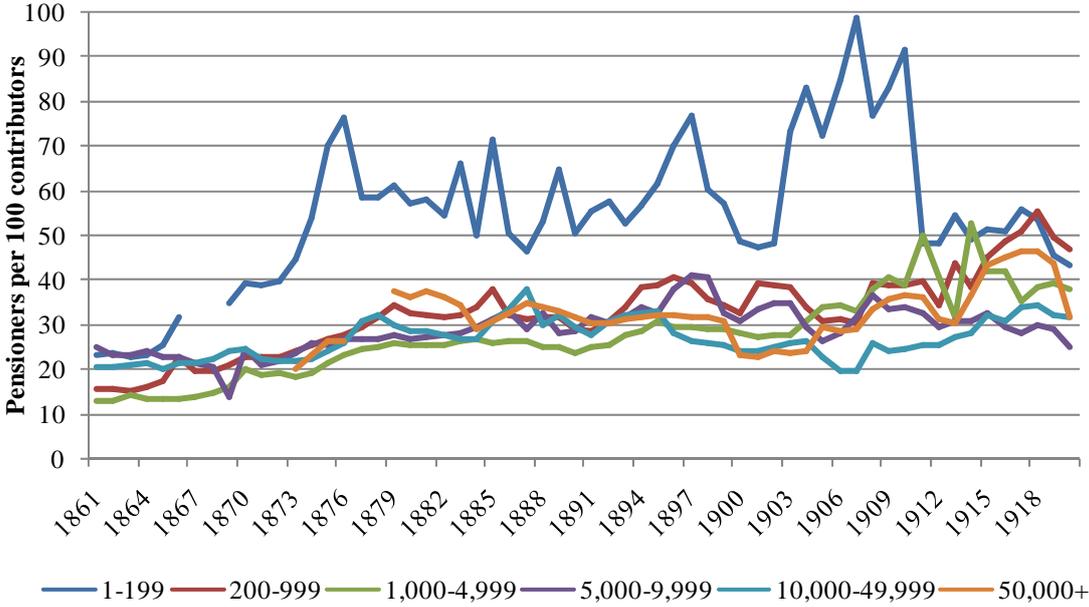


Notes: Contributors include established and unestablished members. Pensioners include invalids, widows and orphans.

Source: Own calculation based on Ministerium für Handel und Gewerbe (1862-1922).

Evidence from Figure 10 details the picture insofar as it reports average PCRs by seven size classes. As one can see, PCRs of more than 50 were especially to find among smallest Knappschaften (below 200 contributors) what definitely put them under financial pressure. However, not only the smallest Knappschaften had to deal with an increasing PCR, but also the rest. For the other size classes, the average burden increased from 12 to 25 at the beginning of the observation period up to 25 to 50 pensioners per 100 contributors towards 1920. Notably, the disparity became larger over time.

Figure 10: Average Pensioners-to-Contributors Ratios by Size Class, 1861-1920



Note: See Figure 10.

Source: Own calculation based on Ministerium für Handel und Gewerbe (1862-1922).

The pensioners-to-contributors ratio as a measure of the (potential) economic implications of demographic and structural ageing is especially important in connection with pay-as-you-go financing. On the micro level, many Knappschaften experienced ageing while, on the macro level, it was not a severe problem for the German Reich towards World War I (see population pyramids in Rothenbacher, 2002: 299-300). We can identify two factors that explain this divergence. Knappschaften were profession-specific and thus the local or regional inflow of new contributors was limited to the expansion of the mining sector. Since Knappschaften were inevitably tied to the extraction of depletable natural resources – or in other words: the spatial distribution of resource deposits of different quality, the local or regional expansion or contraction of mining activities, in turn, determined their long-term growth path.

As argued, Knappschaften used the pay-as-you-go mechanism around which today’s criticism and reform effort are centred (Börsch-Supan, 2000). In particular, the pensioners-to-contributors ratio is the transmission channel through which demographic and structural age-

ing – not necessarily an economic problem per se – enters a pay-as-you-go based pension scheme. In such a scheme, the contribution rate depends on the pensioners-to-contributors ratio, the gross pension level, Reich subsidies and, possibly, reserves Knappschaften accumulated in the past to smooth out seasonal or cyclical fluctuations. Given a long-term relative increase in the number of pensioners, (i) the contribution rate obviously has to be raised ceteris paribus to ensure equilibrium. To avoid this, (ii) the gross pension level could be cut which simply means eliminating a fraction of the Knappschaftens' accumulated implicit debt – to the detriment of young and yet unborn contributors. (iii) Raising Reich subsidies was no alternative because the Reich paid none. Also, (iv) changing the rules concerning the application to retirement may raise the effective retirement age and therefore release the pensioners-to-contributors ratio from some pressure. (v) Finally, a PAYGO scheme could be substituted by a funded scheme (*Kapitaldeckungsverfahren*) with all adjustment burdens connected with the transition.²¹

Now, take a look first at strategy (iii). We can reasonably assume that Knappschaften engaged in sharpening eligibility rules in a way that makes it more difficult for insurants to qualify for an invalidity pension. Though, unfortunately, evidence is rather scarce. Imbusch (1910: 70-71), however, mentions the Märkische Knappschaft, the by far largest Knappschaft until 1889, as an example for a Knappschaft that tried. Regardless of how Knappschaften specifically re-defined eligibility rules in order to control admissions to invalid status, there is one particular variable that can tell us whether efforts led to success or not. Hence, the second stylized fact refers to average durations of invalidity pensions. Data taken from the annual records of the Saarbrücker Knappschaft, the persistently third-largest Knappschaft in Prussia,

²¹ To be precise, there is an implicit relationship between the pensioners-to-contributors ratio and productivity or wages, respectively (Verdugo, 2006). If the working members' wages increased at a higher rate than contributions to pay, an increasing pensioners-to-contributors ratio is not necessarily alarming. I do not check for this in this paper, but random computations have shown that contributions per capita predominantly increased at a higher rate than the miners' average wages.

illustrate the trend.²² The average invalidity pension duration with respect to the pensioners who died during the course of an observed year increased from 5.0 years in 1876 to remarkable 14.9 years in 1920 (Saarbrücker Knappschaftsverein, 1879-1920). So, it should hold that, on average, a Knappschaft had to finance more pensioners, each for an ever-increasing period, with fewer contributors over time. Data from the Prussian Knappschaft statistics confirm rising average pension durations since 1900 for the population of Knappschaften as a whole (8.8 years in that year, 11.5 in 1920). For information, the effective entry age into invalidity stayed, by and large, constant at around 50, though variation among Knappschaften can be observed.

Regarding strategy (ii), the presented replacement rate estimates indicate that Knappschaften, by and large, rather increased the gross pension level than reduced it. Furthermore, by improving the financing mechanism in 1906 (see above), Knappschaft insurance even developed towards strategy (v). Though, the scheme was, as before, not fully funded. In particular, meeting that requirement of the law meant for many Knappschaften to raise their per capita contributions considerably.

Finally, Table 6 shows periodical averages of the ratio of claims costs to be financed by one contributor to mean annual net wage. This enables us to make a basic judgement concerning strategy (i). Claims costs per contributor include all claims cost categories and are, technically, roughly equal to contributions per capita. The ratio indicates how far claims costs to be financed drove a wedge between net labour income and gross labour income. For all mining administration regions and subsectors depicted, the median ratio increased from 1867-1876 to 1877-1886. Even the average maximum ratio did so predominantly. We may carefully say that claims costs – in part endogenous, since Knappschaften specified monetary levels themselves – generally consumed a rather increasing than decreasing fraction of gross wage towards World War I. So, rising cost pressure is evident.

²² Unfortunately, the Knappschaft statistics publishes average pension duration data only since 1900.

Table 6: Ratio of Claims Costs per Contributor to Mean Annual Net Wage by Mining Administration Region, 1867-1918

	Hard coal		Brown coal		Iron ore							
	Bonn		Breslau		Dortmund		Halle		Bonn		Halle	
	Med	Max	Med	Max	Med	Max	Med	Max	Med	Max	Med	Max
1867-1876	4,1	10,4	3,9	4,0	3,8	4,3			2,4	7,6	5,1	10,5
1877-1886	8,0	13,3	6,4	7,1	7,1	10,3	4,6	5,5	4,3	13,2	5,5	8,6
1887-1896	6,8	11,7	6,0	7,2	10,4	16,0	5,2	7,0	5,3	10,3	6,0	8,1
1897-1906	7,3	17,5	5,9	6,6	7,3	8,7	5,1	7,1	4,5	10,4	5,6	7,5
1908-1913	6,3	8,0	8,1	11,2	7,1	7,8	11,5	16,7	6,2	12,5	8,7	15,6
1914-1918	3,9	3,9	6,9	8,0	5,2	5,6	6,8	7,4	5,0	7,2	7,0	9,6

Source: Own calculation based on Ministerium für Handel und Gewerbe (1862-1922); Ministerium für Handel und Gewerbe (1885-1920), statistical part, for wage data of 1884 to 1920; Holtfrerich (1973): 54-56.

5 Conclusion

This paper establishes the main structural characteristics of Prussian Knappschaften within the period 1854-1922, when miners' risk provision adopted (social) insurance character, and approaches the themes size, generosity and financial pressure from a quantitative perspective. The paper is descriptive in nature, and wants to provide an information base from which to start further comparative research on social security mutualism and the evolution of the welfare state. Rather than providing a formal proof that Bismarckian-style social insurance originates to a great extent in profession-specific Knappschaften, this paper presumes Knappschaften were one of its origins. Evidence on structural characteristics suggests that, from 1854 onwards, Knappschaften had almost all, social insurance is connotated with from present day's view.

Summarizing the quantitative part, data point to notable heterogeneity among Prussian Knappschaften with respect to all three themes. However, they also identify trends, by and large all, Prussian Knappschaften had in common: (i) Miners had a preference for sickness and invalidity benefits exceeding the generosity of related institutional or insurance arrangements, respectively. This holds definitely true if we compare them to the more extensive Bis-

marckian scheme since 1883. (ii) Over time, increasing pensioners-to-contributors ratios due to structural and demographic changes and increasing average pension durations due much to gains in life expectancy and structural change became a serious issue, which made adjustments necessary and initialized the proportion of a miner's labour income dedicated to the coverage of social security costs, in all, to increase. Thus, Knappschaften underwent all major trends of the modern, late 20th century welfare state, but not necessarily to the same extent: Increasing social security spending, rising pensioners-to-contributors ratios, concentration and pressure on finances forcing Knappschaften to adjust their fiscal policy according to the mechanics of pay-as-you-go. A clear difference, not tackled in this paper, is connected with the budget structure. Administration costs definitely play a far more important role for today's (pay-as-you-go financed) social insurance systems than for 19th and early 20th Knappschaften.

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