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Tobias A. Jopp

**Old Times, Better Times?
German Miners' *Knappschaften*,
Pay-as-you-go Pensions, and
Implicit Rates of Return, 1854–1913**

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Tobias A. Jopp¹

Old Times, Better Times? German Miners' *Knappschaften*, Pay-as-you-go Pensions, and Implicit Rates of Return, 1854–1913

Abstract

This paper contributes to the literature on the weakness of modern pay-as-you-go social security systems in financing pensions by taking a business and economic historical perspective on the issue. It focuses on Prussian Knappschaften (plural of Knappschaft), which provided miners with compulsory invalidity and implicit old-age insurance, and studies the period from 1854 to 1913. Knappschaften used the pay-as-you-go mechanism, and, in the long-term, came under financial pressure by the rising number of pensioners. The question to be answered is whether Knappschaften were able to offer cohorts of miners entering the system at different times the same implicit rates of return. Did Knappschaften provide an intergenerationally sustainable policy, or did adjustments of contributions and other parameters decrease the dividend for insured miners over time?

JEL Classification: N33, N83, H53, H55

Keywords: Insurance; implicit rates of return; Knappschaft; mining; pay-as-you-go; pensions; Prussia; welfare state

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Introduction

It is often claimed that the ageing process that many industrialized countries have undergone for decades—and will continue to undergo—puts social security systems more and more under financial pressure. Under a constant policy, such as a constant income-replacement rate and a constant subsidy rate, this holds simply because double ageing affects the relation between the working and the non-working population. If social security benefits, pensions especially, are financed by the pay-as-you-go method (PAYGO) rather than being fully funded, changes in the pensioners-to-contributors ratio translate into increases in the contribution rate (Börsch-Supan, 1992; Febrero & Cadarso, 2006). The diagnosis may culminate in making the case for a system that is likely to burden future generations overproportionally because of its sensitivity to changes in demographic parameters. Thus, postponing financing burdens into the future, which the PAYGO system does, implies intergenerational redistribution that hurts future contributors and pensioners by reducing the implicit rate of return, which they can earn (Galasso & Profeta, 2004). For Germany, there are only a few recent studies that empirically assess implicit rates of return in the PAYGO system for different cohorts. Schnabel (1998), for instance, finds that rates of return decreased between 1930 and 1980 over cohorts; in an optimistic scenario, a single male born in 1930 could expect a rate of return of 2.1 per cent, while a single male born in 1980 could expect a rate of return of -0.4 per cent. Evidence from Börsch-Supan and Reil-Held (2001) also highlights decreasing implicit rates of return over time. Others claim that the problem is not how the PAYGO mechanism works—that there is no technical weakness at all. The problem, rather, is in the political economy of the system. Short-run oriented and vote-maximizing politicians, who ought to adjust the economy to long-run challenges, actually resist certain reforms (reducing the replacement rate, raising the legal retirement age, or neutralising adverse incentives to retire earlier). The bottom line is that policy makers are aware of PAYGO-related reform measures that would, among other things, take pressure off the contribution rate, but they choose not to implement them (Casamatta et al., 2000; Cremer & Pestieau, 2000; Galasso & Profeta, 2004; Galasso, 2008). Another point of view is that it is all a matter of economic progress and productivity growth: If governments' economic policy would create an environment that is investment- and innovation-friendly as well as competitive, and, perhaps, induce further economic activity by stimulating demand, industrialised countries should be able to eliminate the financing problems related to their social security systems (Concialdi, 2006; Wray, 2006).

This paper aims to contribute to the literature on the weakness (alleged, perhaps) of modern PAYGO social security systems in financing pensions by taking a business and economic historical perspective on the issue. This undertaking has potential since the PAYGO pension insurance system has a quite long tradition, at least in Germany. *Knappschaften* (singular *Knappschaft*), the mutual insurance funds of German miners, provide the historical context for this paper.¹ In particular, I focus on the business history of all 103 Prussian *Knappschaften*, the most important, and comparatively best-documented funds. The study period covers the years 1854 to 1913, the formative period of the German welfare state. Because it was in 1854 that the miners' *Knappschaften* took on the character of insurance funds thanks to liberal Prussian mining reform, this year seems to be a natural starting point. The beginning of the First World War seems to be a natural end point for this study.

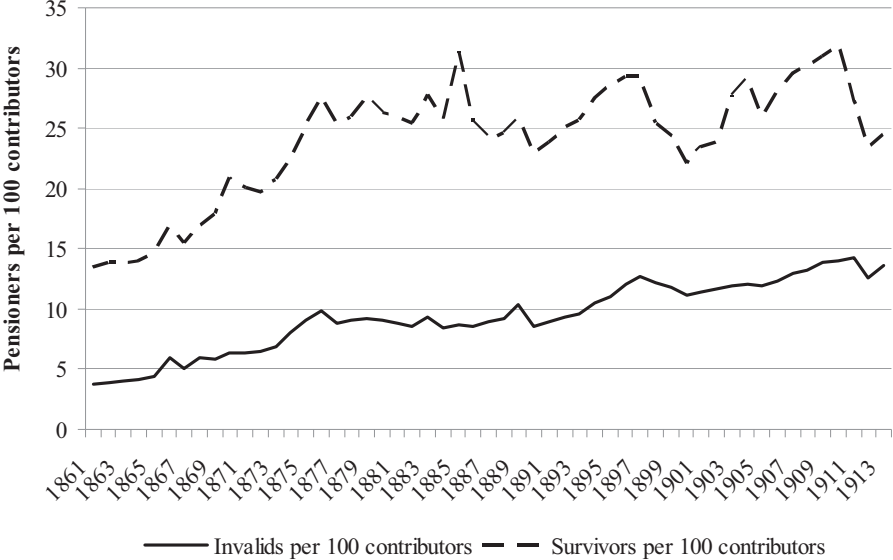


Figure 1. Average number of invalids and survivors per 100 contributors per *Knappschaft*.

Note: Survivors are widows and orphans.

Source: Ministerium für Handel und Gewerbe (1862-1915).

What makes the *Knappschaften* an appropriate historical example? What is the research question this paper wants to answer specifically by focusing on them? Concerning the first question, the *Knappschaften* insured miners against the major life risks—including sickness, invalidity, and survivorship—and granted sick pay and pensions as their main insurance

benefits. One may argue that invalidity insurance is not old-age insurance and, thus, may not be subject to the same problems. However, I argue that this distinction does not matter in this particular case because both invalidity pensions and survivorship pensions were paid until death of the pensioner, hence implicitly insured them against longevity. *Knappschaften* used the PAYGO mechanism, and membership and payments of contributions were compulsory, with each *Knappschaft* having its own PAYGO equation to react on. They also accumulated reserves, but these were never sufficient to cover a substantial amount of the implicit liabilities. In fact, there is reason to conclude that *Knappschaften* were under massive pressure from a continuously rising proportion of pensioners, who were economically dependent individuals. Figure 1 conveys a first impression of what was going on. The average number of invalids (survivors) per 100 contributors per *Knappschaft* increased from about four (14 dependent retirees to 14 (more than 25), or by 357 (at least 181) per cent.

Concerning the second question, this paper focuses on the extent to which the *Knappschaften's* business policy might have been intergenerationally imbalanced in view of the pressure on the PAYGO equation illustrated above. The research question is: Did implicit rates of return, which were the dividends the *Knappschaften* paid their insurants, decrease over time? According to Börsch-Supan and Reil-Held (2001), intergenerational balance may be achieved if implicit rates of return remain the same for each birth-cohort. Therefore my hypothesis is that the *Knappschaften's* PAYGO system led to diminishing implicit rates of return, thus raising intergenerational redistribution to the detriment of future miners. This hypothesis refers primarily to the claim that the PAYGO mechanism is weak because of its general sensitivity to demographic changes in the broadest sense. Below, however, I will show that this framework can also link up with the two other claims described above: the 'political economy claim' and the 'growth claim.'

This paper does not argue that the conditions in the nineteenth and early twentieth centuries for *Knappschaften* were the same as for today's industrialised economies' social security systems. Since the *Knappschaften* were job-related, mining-specific factors were important sources of financial challenges (e.g., financial shocks due to massive accidents; structural decline of a mining area and, thus, exhaustion of resource deposits; and worsening geological conditions because of an increasing average depth). Nonetheless, the *Knappschaften's* members might have also experienced increases in life expectancy, for instance, as did the population as a whole at the time. Indeed, this paper identifies a parallel to modern economies in the fundamental economic problem of adjusting finances via the

PAYGO mechanism as a reaction to exogenous or endogenous shocks in the form of rising pensioners-to-contributors ratios.

The *Knappschaft* is an old institution and a neglected field of research in business and economic history. Thus, telling a story about German *Knappschaften* may be a valuable undertaking simply because they remain an unknown piece of German insurance history. The *Knappschaften* have significance as one of the job-related origins of Bismarckian-style compulsory health and pension insurance and—indirectly—of every related social insurance system today (Wagner-Braun, 2002, pp. 28-32; Bartels et al., 2009, Guinnane & Streb, 2009, pp. 4-9). Astonishingly, however, the *Knappschaften* are quite absent from the English-speaking literature.² For example, in his book *The Origin of the Welfare State in England and Germany, 1850-1914*, E. P. Hennock (2007) mentions *Knappschaften* only briefly. In its introduction to the historical evolution of pension systems, *The Oxford Handbook of Pension and Retirement Income* (Thane, 2006; Arza & Johnson, 2006) does emphasize the important role of the Bismarckian social legislation for today's benefit systems, but treats the mining sector as some unspecified forerunner. Van der Linden (1996) deals with a wide range of mutual aid organizations, such as German *Hilfskassen* and Friendly Societies in Britain and abroad, but offers no information on *Knappschaften*.

This paper does contain links to business history and the business history literature. To begin with, from a formal point of view, it uses firm-level data and, thus, assesses a problem—the sustainability of PAYGO systems—at the micro level that is usually, at least in my perception, understood as a problem mattering on the macroeconomic level. What is more, *Knappschaften* were shaped to a considerable extent by government regulations, which converted them into a kind of job-related social insurance. The *Knappschaften*, however, were mutual insurance funds operating not for profit and independent of each other; and—this is probably the most important point—they imply collective solidarity. Though the quality of 'compulsory solidarity' might have been different from that of pure voluntary solidarity, as in the Friendly Societies (Guinnane & Streb, 2009, p.10; Pearson, 2003, p. 51), this solidarity was going to be tested towards 1913. Hence, referring to Pearson (2002), for example, the *Knappschaftens'* story might be seen as another case of 'mutuality tested', yet in a different insurance context. There is also a link with the story of English pit clubs (Benson, 2002). Benson argues that it was a general problem for those clubs' solvency that they were tied to a particular mine and, thus, mine owner. The German miners' *Knappschaft* system was different in that many funds covered a whole mining area and were, thus, arguably less

exposed to the fate and interests of only one owner. Whether those larger funds could better maintain their solvency, however, must be determined empirically.

The research question is answered in three consecutive steps. First, I sketch the history of the *Knappschaften* from their beginnings in the mediaeval period (around 1260) to the Prussian mining reform, 1851-1865, followed by a basic description of how they were regulated. The latter, in particular, seems necessary because, as mentioned before, the German miners' *Knappschaften* have been quite neglected in the (English-speaking) literature. Second, I analyse the quality of the *Knappschaften's* exposure to financial challenges in more detail. Here, the focus on Prussian *Knappschaften* is justified for two reasons: i) Because Prussia was the core region of mining activity in the study period, it accounted for the vast majority of miners; and ii) the Prussian ministry of trade and commerce reported annually, beginning in 1861, the balance sheets and membership composition of all *Knappschaften* there (*Statistik der Knappschaftsvereine des preussischen Staates*, KV statistics hereafter). These data provide insights into the *Knappschaften's* operation. Finally, as a third step, I present implicit rates of return for a number of *Knappschaften* and clarify their implications for intergenerational imbalance.

The *Knappschaften* and their economic niche: industry-related insurance

In mediaeval times, German miners relied on their own structures of mutual self-help in case of income loss due to injury, sickness and permanent incapacitation of the breadwinner (Lauf, 2004, p. 115; Bartels et al., 2009, p. 197). Local associations of the *Knappen*, as miners were called at the time, were first founded in the Harz and Erz Mountains. In fact, these early associations fit well into the picture of emerging collective action in Western Europe (De Moor, 2008; Ogilvie, 2004). Contributions to the associations were voluntary and collected when they were needed, usually after an accident. Initially, there was not an established permanent reserve fund that was regularly refuelled. Benefits in the form of single payments were not high and were granted as charity. A legal right to be supported by one's own *Knappschaft* (abbreviated by KV hereafter) also did not exist. Miners' 'social security' mutualism, then, developed in several stages. Soon, members began making regular contributions (*Büchsenpfennig*) that were used to build up permanent reserve funds. Various local and regional mining codes enacted at the beginning of the fourteenth century strengthened compulsion and also often required the proprietors of mines (*Gewerken*) to share

in the costs of sickness and invalidity claims. Hiltrop explains that owners often had to provide replacement pay for sick miners for four to eight weeks, while support for those permanently disabled came directly from the KVs (Brassert, 1858; Hiltrop, 1869; Karwehl, 1907, p. 15-17). After the miners' KVs had been incorporated into the absolutistic regime that emerged around middle of the sixteenth century, patronage by the sovereign became a substitute for miners' fraternalism. Since it was a characteristic of the absolutist-mercantilist state to administer the exploitation of natural resources in every respect, miners and mine owners were, in fact, at the royal administration's mercy (Kaufhold, 1994). It was during the eighteenth century that Prussia, with its hard-coal deposits, emerged as the new mining core region (Bülow, 1905, pp. 34-62; Bartels et al., 2009, p. 198; Tenfelde, 2004, p. 21). In addition, Prussia's mining legislation of 1851-1865 removed the absolutist-mercantilist economic order in favour of a more liberal economic framework, allowing mine owners a free hand in all business-related decisions and converting the KVs from charitable organizations into insurance providers. The state resumed the position of a passive supervisor (Brown, 1995; Fischer, 1961a; Fischer, 1961b).

The various German KVs of the second half of the nineteenth and the early twentieth centuries became mutual, non-profit insurance providers for mineworkers and also for employees in the related industries of steel production and ore processing. Although government regulations required KVs to act as social insurance funds, it is important to bear in mind that each KV acted on its own and never received state subsidies during the study period. Compulsory membership and, thus, obligatory contributions continued to be the practice in the mineworkers' *Knappschaften*. In particular, following Wagner-Braun (2002, pp. 32-33), *Knappschaft* funds can be looked upon as the definite predecessors of statutory state insurance in Germany. In the study period, KVs in Prussia, and soon in almost all states of the German Reich (except, for example, Saxony), were regulated according to the *Knappschaft* law of 1854 (Friedrich Wilhelm IV., 1855), the Prussian general mining law of 1865 (Klostermann, 1866) and the new *Knappschaft* law of 1906 (Steinbrinck, 1908). In practice, the *Knappschaft*'s funds had to fulfill various insurance functions.

KVs had to be refounded in every area where mining and complementary economic activity, such as steel production and ore processing, took place. Table 1 shows how many Prussian KVs existed during the study period. In 1861, the first year for which the *Statistik der Knappschaftsvereine des preussischen Staates* reported data, 71 KVs were in operation; this number increased to a remarkable 91 by 1870/1871. Then, due to mergers and closures and very few new entries, the number of KVs decreased to 62 in 1913. For illustrative

purposes, Table 1 also reports the number of KVs in Bavaria, Saxony and the rest of the German Reich. Prussia consistently accounted for half or more of the existing KVs.

Table 1. Number of German *Knappschaften*, 1861-1913.

Year	Prussia	Bavaria	Saxony	Rest
1861	71	n.a.	12	1
1866	77	n.a.	12	1
1871	91	n.a.	53	2
1876	87	n.a.	53	6
1881	83	n.a.	41	7
1886	75	39	29	18
1891	74	40	3	18
1896	73	41	3	12
1901	73	41	3	17
1906	72	28	3	20
1911	65	28	3	21
1913	62	26	3	21

Note: 'n.a.' is 'not available.' For Saxony, only the number of Knappschaft pension funds is reported. The 'rest' includes KVs located in the Kingdom of Wurttemberg, the Grand Duchy of Hesse, the Grand 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. Compared to the data on Prussia, Bavaria and Saxony, official data on the rest are even scarcer; however, some data were located in the secondary literature, but have to be taken with caution.

Source: Ministerium für Handel und Gewerbe (1862-1915); Oberbergamt München (1884-1915); Königliches Finanzministerium Sachsen (1870-1872); Königliches Finanzministerium Sachsen (1873-1914); Karwehl (1907), pp. 142; Simons (1895), pp.14-22; Imbusch (1910), pp.98-128; Köhne (1911), pp. 92-96.

The various Prussian KVs were located in so-called mining administration regions (*Oberbergamtsbezirke*). Figure 2 locates those regions: Bonn, Breslau, Clausthal, Dortmund and Halle. 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, of course. Dortmund comprised what were probably the single most important European coal fields at the time, the Ruhr coal fields, dominated by only a few large KVs. In the Breslau region, the important Lower and Upper Silesian coal fields were situated. The Saar and Aachen coal fields were located in the Bonn region. 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 miscellaneous ores (copper, lead, etc.)—were extracted primarily in the Bonn, Clausthal and Halle regions. Consequently, KVs for related activities (steel production, ore processing) were situated there, too. Salt and stone extraction existed mainly in Bonn, Dortmund and Halle.

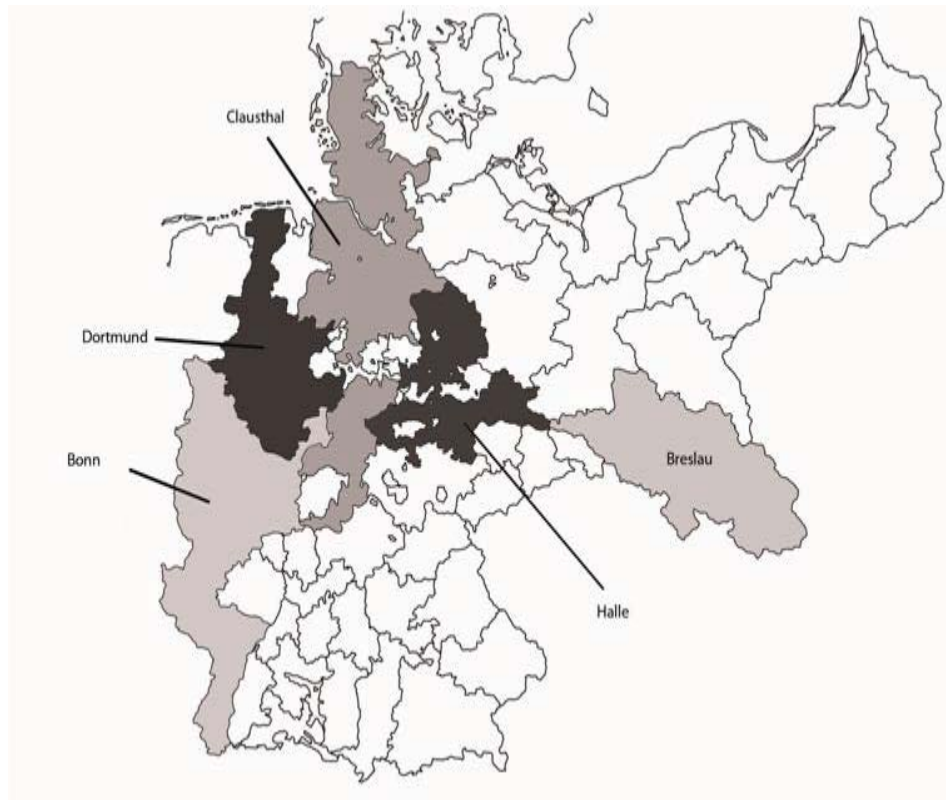


Figure 2. Location of the Prussian mining administration regions within the German Reich (around 1871).

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

Principally, we have to distinguish two different types of funds. The one, more frequently occurring, is the area Knappschaft (*Bezirkknappschaft*) that operated an insurance scheme contingent on the number and size of the mining enterprises located within the boundaries of its area. The other was the firm-related one (*Werksknappschaft*), usually situated within the area of another KV and, because of the linkage to a single company, comparatively smaller. Linking particular KVs to certain areas is somehow reminiscent of assigning territorial monopolies (such as the large German energy suppliers in the second half of the twentieth century). This is the more so because no KV could have had a subsidiary within another's area. Consequently, competition was not seen in the free movement of services by KVs, but—if at all—in the mobility of insureds.

Each KV insured its members—miners and their dependants—against the financial consequences of the contingencies of life: injuries, sickness, invalidity, survivorship, and old age. The respective prescribed benefits included: (1) health care benefits for 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. This article focuses, of course, on (3), leaving out the other benefit categories for the most part. Regarding the level of the invalidity pension benefit, KVs had a free hand in specifying amounts and calculation principles. The industry regulator did not even set minimum monetary standards or eligibility criteria. The fact that KVs had so much room to maneuver explains most of the heterogeneity among them. Invalidity pensions predominantly consisted of a flat rate, varying in its level between KVs and interpretable as a minimum pension, plus build-up rates for each contribution period during employment (week, month or year). These rates often depended on the classification of the miner according to his length of service, wage, or occupation within the mine; build-up rates also varied across insurers. In particular, there is no indication that KVs directly indexed pensions, once granted, to price inflation or productivity; a miner receiving a nominal annual pension of 100 marks in one year would most likely have received those 100 marks also in the subsequent years.⁴ Each KV 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, meaning that the miner could no longer earn one half of his actual wage in his occupation in the mining sector. In contrast, Bismarckian invalidity insurance (introduced in 1889) 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 his particular job. Thus, the KVs' eligibility criteria can

be labelled, by and large, as comparatively less strict (Geyer, 1990; Frerich & Frey, 1993, p. 100). Finally, survivors' pensions were usually specified as a proportion of invalidity pensions (often 50 to 60 per cent for the widow's pension and ten to 20 per cent for the orphan's).

Regarding revenues, KVs financed themselves mainly through contributions, but also through interest on assets and various fees (e.g., entrance, punishment, and marriage fees). They were allowed to charge a payment of contribution either as a fixed amount per contributor or as a percentage of labour income. We know from contemporary observers that KVs predominantly charged a fixed amount per period (week, month or year). This was either the same for every contributor regardless of individual characteristics, such as seniority, biological age, occupation within the mine (e.g., hewer underground or assistant worker at the surface) or wage class, respectively, or was scaled according to one or more of these individual characteristics. How a particular KV actually scaled contributions and dues was decided only by the KV members' representatives in self-management (and not according to what the mining administration might have wanted) and was published in the KV's statute. However, this article does not use detailed KV-level information on scaling. Like compulsion and local organization of KVs, shared financing between mineworkers and mine owners had a long tradition, too. The law of 1865 prescribed that employers had to pay a minimum of 50 per cent of the contributions mineworkers paid. Thus, financing was not necessarily on equal terms; the average firms' portion of total contributions over all KVs was, thus, less than 50 per cent. However, in 1906, the firms' obligatory portion was increased to the same amount mineworkers had to pay on aggregate.

Finally, the way the KVs self-management really worked in practice—thus how the parties involved influenced the decision-making process—is kind of a black box. Owing to the law of 1854, KVs were no longer run by state officials. Instead, each KV formed a managing board with an equal number of miners' representatives and mine owners' representatives. While the latter chose their representatives directly, miners chose the so-called Elders (*Älteste*), who, in turn, elected miners' representatives for the board. The Elders, who could have been active workers or retirees, were probably chosen by workers because of their prestige among the local membership. Both the 1854 and 1865 laws allowed the Elders to elect ordinary KV members or even mining officials (private or state) to the board. It is a widespread theme of nineteenth-century writings, as well as of recent historical works, to claim that mine owners, via their representatives, constantly had relatively stronger influence in self-management. The miners' chosen representatives were usually said to be friendlier

toward their bosses—the mine owners—than to the miners they were elected to represent. The Elders, as intermediaries, are said to have made the difference in favour of a stronger position of employers in self-management (Tenfelde, 2004, pp. 26-33). According to Lauf (2006, p. 272), it is not surprising that owners dominated the decision process effectively because they were the intellectuals. Heinrich Imbusch (1910, p. 63), who became the trade union leader of the *Gewerkverein christlicher Bergarbeiter* in 1918, stressed that many mine owners intended to use KVs to monitor and discipline their workforce: “Many employers saw in the KVs an instrument to pursue their own interests. The KVs’ and, thus, the workers’ interests had to be subordinated to owners’ intentions.”⁵ Ferdinand Bertrams (1912, p. 1413) points to the fact that mine owners had an interest in establishing a settled—that is, immobile—stock of experienced miners. This makes sense, as working as a productive hewer at the time, and probably still today, required a learning-by-doing process; taking a young, inexperienced miner to his most productive level was, thus, a costly investment for the mine owner. So, no mine owner would have been willing to develop a productive worker, only to lose him to another mine owner, which would have felt to him like an expropriation of future returns.

I have not yet been able to locate source material on board meetings. Contemporary observers are also not very informative about how decisions on contributions and benefits were made and justified. However, we can be quite sure that KVs ran an expenditure-oriented revenue policy; that is, they specified, for a given time interval, the monetary level of benefits and formed in some (yet unknown) way expectations on aggregate claims costs, which were converted into an average contribution required; they also accounted for expected miscellaneous revenues and room for maneuver because of accumulated reserves. That is to say, we *can* assess how average contributions and average benefits were effectively adjusted from an historical perspective because we have the quantitative data from the KV statistics. What are harder to assess are the underlying ideas and the actuarial knowledge used.⁶

Having seen this basic information on the institutional design of the *Knappschaften*, we can now look at Table 2, which reports some more key data on Prussian KVs as a whole, highlighting secular trends in the study period. While the number of KVs decreased towards World War I, the total number of insureds—contributors and pensioners together—increased notably from 140,000 to 965,000, or by 3.78 per cent per year. As a measure of the KVs’ social significance, the share of total members in the German population is employed. Coverage increased from a mere 0.37 per cent to roughly 1.5 per cent; although this was not really high in the national context, it nonetheless increased, too. Moreover, the rising total membership in combination with a decreasing number of insurance funds implies that fund

size must have grown increasingly large, on average. Here, I measure the size of a KV in terms of contributing miners exclusively. I thereby measure the true financing power a KV had by relying on a certain number of payers. Displayed are mean KV size and median KV size. Both measures are proposed in the literature as practical proxies for the minimum efficient size of an insurer (Eisen, 1991). Mean size increased from 1,675 contributors per KV to about 12,000, while median size increased only from 449 contributors per KV to 1,300. The difference between the two measures is a straightforward indicator of how skewed the annual KV size distribution was; here, it implies a right-hand tail. In particular, the relative frequency of small KVs persistently operating at small scale (below 500 contributors) always was at least 30 per cent per year. A contemporary observer, Harry Karwehl, emphasized retrospectively in 1907 (p. 71): “The German Knappschaft obviously suffers from cancer: It is the fragmentation into many small funds.”⁷

Table 2. Key data of Prussian *Knappschaft* funds, 1861-1913.

Year	Number of members		Fund size		Pension costs		Total assets in 1,000 marks
	in 1,000 persons	in % of German population	Mean	Median	in 1,000 marks	in % of German NNP	
1861	140	0.37	1,675	449	1,788	0.01	2,964
1866	179	0.48	2,069	463	2,778	0.02	3,778
1871	275	0.67	2,492	566	3,971	0.02	5,075
1876	328	0.76	3,069	746	7,332	0.04	19,496
1881	376	0.83	3,487	667	10,121	0.05	23,467
1886	439	0.93	4,442	944	14,651	0.06	29,607
1891	561	1.13	5,878	1,049	16,792	0.06	46,691
1896	623	1.18	6,426	1,025	22,032	0.07	74,416
1901	793	1.39	8,722	941	27,446	0.07	114,469
1906	913	1.49	10,271	1,300	31,627	0.07	153,592
1911	900	1.36	10,523	1,039	38,208	0.08	268,015
1913	965	1.44	12,102	1,168	39,242	0.07	331,822

Note: 'Members' includes contributors and pensioners. 'Fund size' is measured in terms of contributors. 'Pension costs' include invalidity and survivorship pensions and are measured in 1913 prices. 'NNP' is net national product. NNP and assets are also in 1913 prices.

Source: Ministerium für Handel und Gewerbe (1862-1915) and Hoffmann (1965), pp. 599-601.

The table, moreover, shows that real pension costs increased in absolute terms as well as in relation to real net national product (NNP); the latter observation implies benefit growth at a higher rate than that of the whole economy and, thus, tells of the prosperity in the German mining sector at the time. Before 1908, real total assets displayed relate to the KVs' pension and sickness insurance sections together. Assets include cash reserves, bank deposits and fixed-interest-bearing papers.⁸

The case for financial pressure

The relevant regulations for KVs, the laws of 1854 and 1865, did not prescribe whether KVs should use the PAYGO method (*Umlageverfahren*) or funding (*Kapitaldeckung*). Contemporaries inform us that KVs used the former, thus converting in each year the contributions of working members into pension benefits for non-working invalids and survivors, while private life insurers concentrated on the latter (Caron, 1882, p. 7; Bertrams, 1912, p. 1417; Köhne, 1915, pp. 18-19). It might have been that the PAYGO mechanism was appealing to KVs because it was easy to implement, and pensions could be paid immediately, so no prior capital accumulation phase per individual or generation was required. Besides that, both KV officials and contemporary observers might have been very optimistic about the long-term prospect of mining. Simons stated the following in 1895 (p. 13):

KVs take care of accumulating an appropriate amount of reserves. The amount, an issue of debate, is not prescribed by law. Many KVs specified 150 marks per member. . . . A fully funded system is claimed not to be necessary because mining in Germany will not decline any time soon, so that the finances of current and future generations are secure; entitlements of the elderly can always be served by payments of the young.⁹

In 1910, however, Imbusch (pp. 68-69) took a much more pessimistic perspective, especially on the lack of actuarial expertise in many KVs:

Most Prussian KVs have not specified contributions and benefits according to actuarial principles; this would have enabled them to secure permanent solvency. Almost all KVs charged contributions too low and accumulated too little reserves. Total revenues often did not even cover total expenditures. . . . A number of KVs principally required a sufficiently high reserve, especially those whose mining areas might no longer experience prosperity or those on the verge of closure. Contributions were nevertheless often too low. If the KV were going to go bankrupt, . . . promised benefits were cut.¹⁰

The often-claimed sensitivity of a PAYGO system simply stems from the fact that a change in the relation between the number of pensioners and the number of contributors requires a proportional change in the contribution rate, other things being equal. This can be easily verified by a look at the stylized budget equation of a PAYGO system, which is

$$\text{Contribution rate} = (\text{pensioners/contributors}) * (\text{average pension/average wage}) * (1-a). \quad (1)$$

Mechanically, the contribution rate depends on three factors: i) the pensioners-to-contributors ratio (PCR); ii) the gross pension level (ratio of average pension to average wage, GPL); and iii) the degree of subsidisation from the outside (Schmähl, 2001). KVs never received subsidies from the state or other KVs. Instead each KV, small or large, had financial reserves accumulated from past contributions, for example, that were charged ex ante but not required ex post to settle claims. To draw on reserves created in the past could help keep contributions and benefit levels constant, at least for some years.

Let us have a closer look at the development of economic dependency—that is, the development of the KVs' pensioners-to-contributors ratios. It seems reasonable here to take into account two facts that might have implications for the degree of adjustment pressure. The first is: KVs had three sorts of pensioners to support; invalid miners, widows, and orphans. Hence, it makes sense to distinguish between an invalids-to-contributors ratio and a survivors-to-contributors ratio simply because one invalid was usually twice as costly as a widow and six times as costly as an orphan. The second is: The long-term growth performance of KVs is ambivalent. Some were subject to long-term stagnation and shrinkage, while other funds prospered and grew; this was very probably so because each KV was tied

either to one mining area, which could be subject to exhaustion and structural decline over time, or to the fate of one mining firm. Table 3 shows that of 103 observed Prussian KVs, 40 exhibited a negative average annual growth rate during their whole operation in the study period. 63 KVs, in contrast, were quite dynamic in the long run and grew by at least 1.9 per cent per year. Note that size is measured here in terms of contributors; hence, ‘growth’ refers directly to an increasing number of financiers. In addition to showing long-term growth performance by the categories ‘stagnant’ and ‘dynamic,’ the table also shows that growth performance was obviously different—on average—for different KV sizes.¹¹ To distinguish between small stagnant KVs, small dynamic KVs and so on also enables us to assess the claim that sustained positive growth might improve things; actually, it is not the growth of the economy that is addressed here, but the idea that sustained growth in contributors helps keep financing problems to a minimum.

Table 3. Long-term growth patterns among *Knappschaften*.

Size class	Long-term growth pattern of <i>Knappschaften</i>			
	Stagnant		Dynamic	
	Number	Mean growth rate	Number	Mean growth rate
Small ($\approx < 500$ contributors)	24	-5.52 % p.a.	16	1.88 % p.a.
Medium (≈ 500 -12,000 contributors)	15	-3.40 % p.a.	37	3.30 % p.a.
Large ($\approx > 12,000$ contributors)	1	-2.97 % p.a.	10	3.64 % p.a.
<i>Sum</i>	<i>40</i>		<i>63</i>	

Note: KV size is measured in terms of contributors.

Source: See Figure 1.

According to combinations of long-term growth patterns and size classes (stagnant large is omitted because only one KV is involved), Table 4 displays the number of invalids per ten contributors per year (ICR) and the number of survivors per ten contributors per year (SCR),

each averaged over the respective KVs. Obviously, the average burden with pensioners increased significantly. For example, the average small stagnant KV experienced an increase in the ICR (SCR) by about 1.8 (2.1) invalids (survivors) per ten contributors. Only small dynamic KVs seem inconsistent with the trend, at least with respect to survivors.

Evidence on both the ICR and SCR as measures of the economic implications of increasing dependency define the agenda: Long-term adjustment was required. On the micro level, many KVs experienced social and biological 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, pp. 299-300). If KVs tried to react to the rising burden with pensioners by sharpening the eligibility rules— i.e., making it more difficult for insurants to qualify for an invalidity pension—they were not successful. KV-level evidence on institutional adjustments in that direction is rather scarce. Imbusch (1910, pp. 70-71), for example, mentions the *Märkische KV*, by far the largest Prussian KV until 1889 and the dominant one in the Ruhr, which, by 1880, tried to exclude retired miners from pension benefits if they were older than 36 when they started to work as a miner. What is more, geological conditions in the various mining subsectors underlying the KVs' insurance might have worsened over time, causing thereby more injuries and fostering severe diseases. This could have offset gains in work safety.

Table 4. The economic dependency ratio as a measure of financial distress.

Year	Stagnant <i>Knappschaften</i>				Dynamic <i>Knappschaften</i>					
	Small		Medium		Small		Medium		Large	
	ICR	SCR	ICR	SCR	ICR	SCR	ICR	SCR	ICR	SCR
1861	0.40	1.26	0.32	0.94	0.64	2.05	0.26	1.23	0.52	1.61
1871	1.32	2.82	0.40	1.64	0.53	2.22	0.38	1.60	0.53	1.97
1881	1.83	3.78	0.97	3.19	0.41	1.98	0.58	2.13	0.78	2.21
1891	1.57	2.89	1.32	4.44	0.26	1.29	0.61	1.92	0.87	1.91
1901	1.81	2.71	1.56	4.65	0.63	1.65	0.88	1.84	0.94	1.57
1913	2.28	3.41	1.94	5.58	0.90	1.55	1.02	1.91	1.24	1.93

Note: 'ICR' ('SCR') denotes the invalids-to-contributors ratio (survivors-to-contributors ratio). Both ratios say how many pensioners of the respective category had to be financed by ten contributors. The ratios are averaged over KVs in year t.

Source: See Table 2.

Was a rising burden from pensioners a true problem or only a kind of illusion? I ask this because one might claim that 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 did the contributions, an increasing pensioners-to-contributors ratio would not have been alarming, at least not from our ex post perspective.

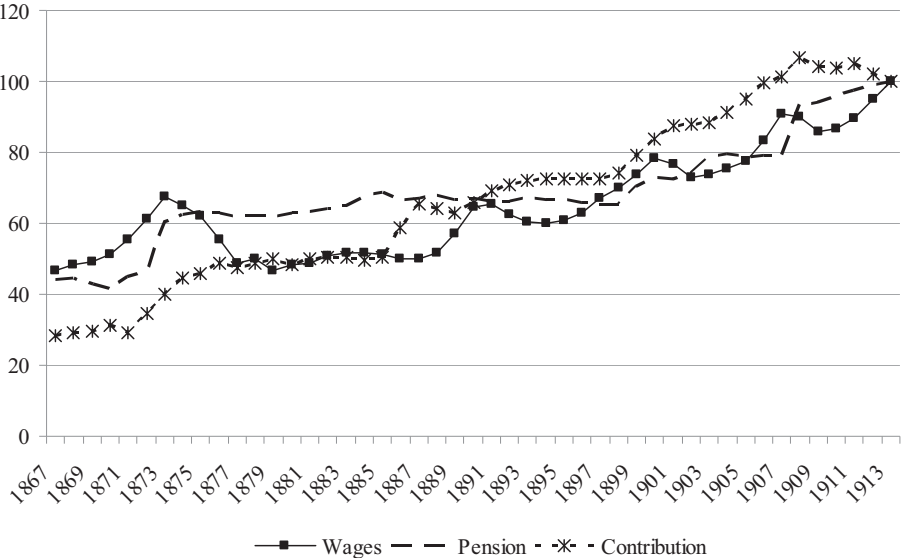


Figure 3. Indices of average contribution, average benefit and net labour earnings growth for Prussian *Knappschaften* as a whole (1913=100).

Source: See Figure 1; Hoffmann (1965), pp. 461.

Figure 3 displays the development of indices of the average contribution, the average invalidity pension and the annual net wage in German mining. Two observations must be

highlighted. Omitting fluctuations due to the business cycle, the indices of the annual wage of the representative miner and of the representative average invalidity pension follow a linear trend with nearly the same slope; the average annual growth of wages was 1.67 per cent, while that of the average pension was 1.79 per cent. Thus, the adjustment of the invalidity pension benefit was broadly linked to wages, even though with a time lag and not directly via the typical pension formula (see above). Moreover, the average contribution charged per year increased at a higher annual rate—by 2.78 per cent—implying that miners who entered later shouldered a comparatively faster-increasing portion of contributions. These two observations do not necessarily apply to a high number of KVs, but to a high number of miners. This is because contributions and pensions are size-weighted, and the size distribution of KVs was extremely skewed to the left with a long right-hand tail.

What about the reactions to the widespread phenomenon of a rising burden from pensioners? To give an answer, Table 5 reports indices of the (non-weighted) average contribution rate and the (non-weighted) average net pension level (NPL) for combinations of long-term growth pattern and size class; absolute quantities are also given for the years 1861 and 1913. In contrast to Figure 2, where Hoffmann's wage series for the whole mining sector (including salines) was used, I try, as often as possible, to ascribe to each KV a wage series corresponding to the main product that was extracted in its area or by the relevant firm(s) (e.g., coal or ore), respectively. I use the *Statistische Mitteilungen über die beim Bergbau Preußens gezahlten Arbeitslöhne und erzielten Arbeitsleistungen*, a statistics framework reporting annual net wage by product and mining area (e.g., hard coal in the Ruhr, brown coal in the Harz region, and iron ore in the Mansfeld mining area). In addition, I use Banken's (1997, appendix 5.4.2) wage series with respect to hard coal mining in the Saar and Holtfrerich's (1973, pp.54-56) wage series with respect to hard coal mining in the Ruhr. Unfortunately, the official wage statistics do not report wage with respect to the related industries (smelting); therefore, I use Hoffmann's wage series on foundries (1965, pp. 468-470). What is more, the official wage statistics also do not report wages for workers in quarries and those employed in salt mining; here, I draw again on Hoffmann's wage series on German mining as a whole. Not many KVs chose to specify a contribution rate rather than a fixed amount in marks per capita. However, knowing the average net labour earnings for miners enables us to convert the average contribution to a rate per year.

In 1882, contemporary observer Albert Caron asserted:

The fact that it is impossible to sustain high pensions with [such] low contributions is irrevocable. It seems reasonable for a KV to be able to grant smaller pensions that are safe for all times, but to finance the good situation at the moment by burdening the future even more.¹²

Evidence in Table 5 supports this view. At the start of the miners' insurance system, all KVs granted, on average, an NPL that was higher in the cases of small and medium stagnant and small dynamic KVs, even much higher than that in 1913. The NPL is an integral part of the PAYGO equation and can be interpreted as the income replacement of the pension benefit in the transition from the last year of employment to the first year of retirement (not to be confused with the lifetime replacement rate; see Whitehouse, 2006). For the time, a replacement rate of 26 per cent was extremely high. Note that in the Bismarckian invalidity insurance, the replacement rate persistently amounted to about 17 per cent before 1913 (Frerich & Frey, 1993).¹³ The obvious message of Table 5 is: KVs could not, on average, sustain what they had promised; even if the average pension in marks had been raised over time, the net pension level could not be kept constant. This is why it should not be surprising that small and medium stagnant, as well as small dynamic, KVs could afford to reduce the contribution rate over time—the NPL was reduced even more. It seems as if prospering medium and large KVs could keep their NPL adjustments moderate over time because they either raised or held the contribution rate constant, respectively. Here, a parallel to the 'political economy claim' can be drawn. While there were no political forces implementing or blocking parametrical reforms (e.g., raising the contribution rate or raising the legal retirement age) or structural reforms (e.g., shift to funding), there were mine owners; they were the ones who arguably dominated the KVs' boards and consequently the decision-making process. A contribution rate under pressure from a rising proportion of pensioners is a potential cost factor for mine owners—even more so if the owners' profits were eroding due to diminishing output from mines near economic or technical exhaustion. An owner would arguably want to save costs in this situation, and contributions to the KVs were costs. In the absence of any constraint on parametrical reform (e.g., a politically guaranteed pension level, as in Germany), we observe that both the contribution rate and pension level served as the adjusting screw. Especially, the net pension level was decreased. This was, of course, not in the interest of old contributors on the verge of being retired and of pensioners. Obviously, they failed to prevent it.

Table 5. Indices of the average contribution rate and the average invalidity pension benefit (1913=100).

Year	Stagnant <i>Knappschaften</i>				Dynamic <i>Knappschaften</i>					
	Small		Medium		Small		Medium		Large	
	ACR	ANPL	ACR	ANPL	ACR	ANPL	ACR	ANPL	ACR	ANPL
<i>Absolute values (%)</i>										
1861	4.5	26.7	6.7	27.3	4.2	23.8	2.8	18.8	5.4	27.5
1871	5.0	14.3	4.3	15.1	3.8	19.2	3.2	16.0	3.9	20.7
1881	7.4	16.1	7.5	14.9	1.9	12.3	4.9	21.5	7.3	32.3
1891	5.9	14.9	6.3	17.2	2.7	14.1	4.9	20.5	7.2	29.1
1901	5.0	12.1	6.2	10.9	2.7	12.1	5.3	18.6	7.7	25.7
1913	3.5	10.8	5.5	12.2	2.7	10.8	4.9	18.6	7.2	24.1
<i>Indices</i>										
1861	129	247	121	224	156	220	58	101	75	114
1871	144	132	77	123	141	178	65	86	55	86
1881	210	148	136	122	69	114	101	116	101	134
1891	168	138	114	141	100	130	101	110	100	121
1901	142	111	112	89	100	112	109	100	107	107
1913	100	100	100	100	100	100	100	100	100	100

Note: The contribution rate per *Knappschaft* is calculated as $((\text{average contribution}/\text{net wage}) \cdot 100)$; the net pension level per *Knappschaft* is calculated as $((\text{average invalidity pension}/\text{net wage}) \cdot 100)$.

Source: See Figure 1; Hoffmann (1965), p. 461 and 468-470; Banken (1997), appendix 5.4.2; Ministerium für Handel und Gewerbe (1885-1922).

Caron tackled the question of what financial sustainability might be in the context of pension provision (again, it makes no difference for this matter that we focus on invalidity rather than old-age pension). Caron (1882, p. 19) substantiates his opinion:

[A KVs' respective performance] is not being able to finance pensions in some years. KVs are rather able to finance pensions at any point in time only if it is clear that they

can always grant the same amount of pensions per capita. Otherwise, present pensioners would benefit to the detriment of future pensioners.¹⁴

There lies some truth in his assessment that is hard to deny: A pension system might be called sustainable if it ensures indefinitely that financing burdens are not transferred in either direction, from present to future or from future to present generations. However, there is also a misinterpretation in his assessment: It is not the absolute amount of the average pension that matters, but the replacement rate. In my perception, contemporary observers, and possibly KVs members too, did not see the difference; this is probably because they never formalized the PAYGO mechanism they were talking about.

Finally, Table 6 displays the ratio of the miners' and the mine owners' payments of contributions. Again, this is done from the perspective of the average small stagnant KV, the average medium stagnant KV, and so on. This should give some indication of how financing burdens were shared between employee and employer. As mentioned in Section 2, miners and mine owners shouldered claims costs jointly, but not necessarily in equal amounts. Until 1906, when financing on equal terms (50 per cent by each party) was introduced, employers usually covered a smaller portion of costs than insurants. In the long term, the miners' portion of costs did not decrease much. While their portion was 26 per cent higher than owners' in 1861, their portion was still 15 per cent higher in 1907; the average small stagnant KV obviously could not induce employers to take on greater financial responsibility. In contrast, the average medium stagnant, as well as medium dynamic, KV significantly lowered the miners' contributors relative to the employers'.

Table 6. Financing pension costs: the ratio of miners' and employers' contributions.

Year	Stagnant Knappschaften		Dynamic Knappschaften		
	Small	Medium	Small	Medium	Large
1861	1.26	1.74	2.07	2.29	1.20
1871	1.22	1.62	1.46	1.92	1.18
1881	1.21	1.55	1.43	1.88	1.08
1891	1.22	1.49	1.70	1.47	1.09
1901	1.25	1.28	1.65	1.42	1.10
1907	1.15	1.24	1.65	1.26	1.10

Note: The ratio is calculated as (total miners' contributions/total employers' contributions).

Source: See Figure 1.

Not for profit, but not without dividend: Implicit rates of return

In essence, the quantitative evidence presented above implies that KVs were broadly subjected to adjustment pressure owing to increasing system dependency. This state of affairs forced KVs to react according to the PAYGO equation. Whether fiscal adjustments were due to conscious and planned or accidental action, they had direct consequences for economic outcomes. The outcome of interest for this paper is the extent of intergenerational redistribution. Like a government, every KV faced an intertemporal budget restriction. Over a KV's operating lifetime, discounted costs must have equalled discounted benefits and initial financial reserves. That is to say, present miners' overconsumption of insurance benefits compared to what has been contributed constrains the amount of benefits consumable by future miners relative to contributions. From the point of view of a representative insured miner, changes in his KV's business policy towards higher contributions or lower income replacement of the invalidity pension benefit must have necessarily had a direct impact on the dividend he could earn by being insured there. Paying contributions to the KV was an investment yielding either a positive rate of return, when lifetime invalidity pension benefits exceeded lifetime contribution payments, or a negative rate of return, when discounted contributions were higher than discounted pension benefits. Ideally, all insured miners who exhibited the same insurance history—that is, an equal number of years of contribution payments and years of retirement—but entered the KV in different years over the course of 1861 to 1913, had earned the same implicit rate of return. According to our experience today, though, I expect to find that implicit rates of return fell over time.

When it reads above that the KVs' invalidity insurance and modern old-age insurance work the same way, this appears to be essentially correct. However, from a technical point of view, there is a difference that has to be mentioned. Invalidity could have occurred at any age: On the one hand, a miner could have entered the mining sector and a KV at age 25, have become disabled at age 30, and have received a pension for 20 years; on the other hand, a miner could have paid contributions for 35 years, have been unmarried, and have died before he qualified for a pension. These extremes constitute a continuum of many possible individual insurance histories. However, I have chosen to focus on one scenario that might be quite representative for the average insured miner: 25 years of service and contributions, followed

by a five-year retirement period. For each KV that was in operation sufficiently long between 1861 and 1913, I calculate the interest rate that leads to equality of discounted contributions and discounted pension benefits. This rate of return is calculated for three entrance cohorts: 1861, 1871, and 1881. Because of the lack of data on age-specific contributions and age-specific invalidity pensions, I calculate the simplest possible model. In this model, the representative miner pays in contributions per year that equal the average contribution computable from the KV statistics times the share of pension costs in all claims costs. The pension payment he receives per year is not indexed to increases in productivity—i.e., remains the same throughout his five years of retirement. Moreover, rates of return are deflated with Hoffmann's price index of consumer goods (1913=100) already used above. Regarding a particular KV, intergenerational redistribution to the detriment of later-entering cohorts occurred if rates of return diminished between 1861 and 1881; this is a within-KV comparison. It is important to note that this model is not really suitable for a comparison between KVs directly. However, if we found a great number of KVs to have provided diminishing rates of return over time for the representative miner, this should strengthen the general hypothesis: Regardless of whether KVs were growing or shrinking, more or less all of them faced an increasing burden from pensioners that led to decreasing returns for the representative insured miner.¹⁵

Table 7 shows estimated implicit rates of return for 52 out of 103 Prussian KVs. In addition to the funds' names and the rates of return, displayed in brackets is the number of full years of retirement a miner having entered in 1871 or 1881 must have additionally experienced in order to receive a rate of return that is not less than the 1861 cohort's rate. This is an important piece of information because the straightforward model used does not itself adjust for gains in longevity; in my framework, I call this effect the longevity compensation. The information depicted in Table 7 needs careful interpretation because results were derived essentially on the basis of a statistical construct. The results, however, have several noteworthy implications. First, in comparison to entrance cohorts 1871 and 1881, the representative miner having entered in 1861 was extremely well-off in the majority of cases. This holds broadly across all long-term growth patterns. The variance is, however, lowest for the largest KVs. An initial real rate of return of 7.86 per cent (*Halberger KV*), for example, fits perfectly into the picture drawn in the previous subsection and matches contemporaries' worries about solvency and sustainability (see the citations of Caron and Imbusch above).

Table 7. Real implicit rates of return per *Knappschaft*, selected entrance cohorts, 25 years of service, retirement period of five years.

Knappschaft	1861		1871		1881	
	Real IRR	Real IRR	Longevity compensation (full years)	Real IRR	Longevity compensation (full years)	
<i>Stagnant small KVs</i>						
Eschweiler Pümpchen KV	5.23 %	0.74 %	9	-0.15 %	9+	
Halle Saline KV	0.42 %	0.93 %	-	-0.76 %	1	
Hohenzollern KV	7.38 %	2.57 %	9+	-1.75 %	9+	
Münster am Stein KV	-1.35 %	1.29 %	-	0.04 %	-	
Rheinböller KV	10.35 %	6.20 %	9+	2.59 %	9+	
Rothenfelde KV	-	-3.39 %	-	1.02 %	-	
Sassendorf KV	2.92 %	-0.45 %	6	-3.58 %	9+	
Werl KV	1.18 %	0.84 %	1	-1.28 %	3	
Westernkotten KV	3.56 %	4.76 %	-	1.79 %	2	
<i>Stagnant medium KVs</i>						
Brilon KV	4.43 %	-0.22 %	9	-0.42 %	9+	
Deutz KV	6.06 %	1.44 %	9+	-2.63 %	9+	
Eschweiler KV	1.66 %	-1.00 %	3	-2.12 %	4	
Müsen KV	6.16 %	4.83 %	2	1.94 %	9+	
<i>Dynamic small KVs</i>						
Cottenheim KV	-	8.82 %	-	7.02 %	3	
Minden KV	3.74 %	-3.94 %	9+	-6.76 %	9+	
Niedermendingen KV	-	-1.31 %	-	1.16 %	-	
Stromberger Hütte KV	9.41 %	8.62 %	2	6.58 %	5	
St. Goar KV	9.49 %	5.72 %	+9	2.29 %	9+	
Thüringen KV	-	1.36 %	-	3.50 %	-	
Wittgenstein KV	12.33 %	6.79 %	9+	0.75 %	9+	
<i>Dynamic medium KVs</i>						
Arnsberg KV	5.01 %	2.20 %	5	0.44 %	9+	
Brühl KV	4.60 %	1.89 %	3	8.99 %	-	
Burbacher Hütte KV	13.54 %	7.65 %	9+	4.75 %	9+	
Dillinger Hütten KV	4.54 %	3.98 %	1	4.28 %	-	
Eifel KV	5.99 %	1.88 %	9	-1.47 %	9+	

At the beginning of their insurance era, KVs were very—perhaps too—generous; miners profitted from very modest contributions over 1861-1886 and comparatively high invalidity

pensions by the end of the 1880s. Regardless of whether the absolute amount of invalidity pensions or the income replacement rates were in any sense sufficient to ensure subsistence, miners earned a high return on their invested contributions. This finding reflects, on the firm level, what is called the ‘first generations’ effect.

Table 7. Continued.

Knappschaft	1861		1871		1881	
	Real IRR	Real IRR	Longevity compensation (full years)	Real IRR	Longevity compensation (full years)	
Halberger KV	7.86 %	5.95 %	3	9.45 %	-	
Heller KV	4.60 %	2.39 %	3	0.55 %	9+	
Hostenbach KV	0.55 %	-0.14 %	1	-0.98 %	2	
Mayener KV	-	9.60 %	-	5.32 %	9+	
Neunkirchen KV	6.86 %	5.52 %	2	7.25 %	-	
Olpe KV	4.61 %	1.82 %	4	1.16 %	5	
Quinter KV	7.63 %	7.61 %	-	3.88 %	9+	
Rheinischer KV	6.36 %	0.71 %	9+	-2.09 %	9+	
Rheinpreussen KV	-	8.91 %	-	7.21 %	3	
Siegen KV	5.50 %	2.30 %	6	0.70 %	9+	
Stolberger KV	6.87 %	2.47 %	9+	0.74 %	9+	
Wetzlar KV	4.56 %	1.48 %	5	-0.84 %	9+	
Pless KV	-	4.96 %	-	5.69 %	-	
Cassel KV	-	-0.20 %	-	-1.43 %	1	
Georgs-Marien-Hütte KV	-	9.85 %	-	5.23 %	9+	
Ibbenbüren KV	0.63 %	-4.88 %	9+	-10.30 %	9+	
Finowkanal KV	0.79 %	0.35 %	1	2.85 %	-	
Lauchhammer KV	4.52 %	2.42 %	3	3.88 %	1	
Rüdersdorf KV	4.67 %	3.11 %	2	-1.92 %	9+	
Tangerhütte KV	8.32 %	5.19 %	7	6.21 %	3	
<i>Dynamic large KVs</i>						
Bochum Allgemeiner KV	2.44 %	-0.81 %	4	-0.52 %	4	
Clausthal KV	-	0.31 %	-	-4.26 %	5	
Halberstadt KV	4.84 %	4.25 %	1	3.35 %	2	
Mansfeld KV	5.24 %	5.61 %	-	2.85 %	4	
Niederschlesien KV	4.43 %	2.83 %	2	3.14 %	2	
Oberschlesien KV	4.16 %	2.36 %	3	1.33 %	4	
Saarbrücken KV	2.39 %	0.79 %	2	-2.84 %	9+	

Note: Size is measured in terms of contributors. Implicit rates of return (IRR) are rounded and in 1913 prices.

Source: See Table 2.

Second, real implicit rates of return diminish for the majority of KVs and entrance cohorts 1871 and 1881. However, there are KVs that even increased the rate over time (e.g., *Münster am Stein KV*, *Thüringen KV*, *Brühl KV*, *Halberger KV*). The *Brühl KV*, one of the dynamic medium KVs, experienced the highest average annual growth rate of all KVs. Out of 39 dynamic KVs, 11 managed to maintain a U-shaped pattern: rate for 1861 cohort > rate for 1871 cohort < rate for 1881 cohort. Whenever rates of return diminished constantly over time, this implies intergenerational redistribution of financing burdens to the detriment of later or, respectively, future generations of miners. So holding the representative insurance history constant, especially the duration of retirement, the majority of KVs—regardless of their long-term growth path and their size—could not maintain intertemporally stable rates of return.¹⁶

Yet in order to derive a more robust judgement of whether KVs redistributed financing burdens to future generations, we need to take the longevity-compensation information into account. The number in brackets in Table 7 tells us for how many additional full years a miner of the respective entrance cohort would have needed to receive his pension to realize a rate of return not below the reference rate of the 1861 cohort. Therefore, I try to take gains in longevity into account. In order to get an impression of the extent of gains in longevity, I refer to data on average pension duration. Unfortunately, these data are available beginning only in 1900. As reference, I consider data on the largest KVs. Table 8 shows the average invalidity pension duration for those KVs for selected years, as well as the average change in that duration. In all but one case, the *Halberstadt KV*, the average annual change in the pension duration is positive over the period 1900 to 1913.

Let us first have a look at the dynamic large KVs. Table 8 implies that the average pension duration in the first decade of the twentieth century is, for every KV, longer than the five years assumed in the model. For all but the *Saarbrücker KV*, it seems possible, looking back at 1871, that the representative miner could well have received a pension for the required additional years. This leads to the conclusion that the largest and fastest-growing KVs could well have maintained an intergenerationally neutral business policy. Hence, we can reject the hypothesis elaborated above with respect to this group of KVs. Obviously, taking gains in longevity into account, the solidarity of the large KVs does not appear to have been truly tested; their operations were quite sustainable. In particular, this evidence fits the ‘growth claim,’ but from a firm-level perspective.

Table 8. Average invalidity pension duration of the dynamic large *Knappschaften*, 1900-1913.

	1900	1903	1906	1909	1913	Average annual change in pension duration
Allgemeiner KV Bochum	7.8	6.8	7.2	10.1	10.9	+ 0.23 years
Clausthal KV	8.0	10.0	8.7	9.0	11.0	+ 0.23 years
Halberstadt KV	10.1	8.1	6.1	11.1	8.4	-0.13 years
Mansfeld KV	7.1	7.6	7.9	9.1	9.0	+ 0.15 years
Niederschlesien KV	7.6	7.0	7.0	7.5	9.7	+ 0.16 years
Oberschlesien KV	10.6	8.2	7.6	10.6	11.1	+ 0.04 years
Saarbrücken KV	10.4	12.3	12.1	12.7	14.8	+ 0.34 years

Note: The KV statistics display the average invalidity pension duration in year t as the number of years, the invalids that died in that particular year, received their pension on average.

Source: See Table 2.

With regard to the KVs that did not maintain a U-shaped pattern, the longevity-compensation information indicates that they had redistributed financing burdens towards later generations of miners. Take, for example, the *Rüdersdorf KV*. It is not impossible from an ex post perspective that the representative miner of entrance cohort 1871 might have received two additional years of pension to experience the same rate of return as the 1861 cohort. However, it appears impossible that the representative miner of 1881 received a pension for additional nine years or more. Actually, the expression ‘9+’ says in most cases that a longevity compensation of more than ten years would have been necessary to treat the 1861 entrance cohort equal to the 1861 entrance cohort. All the KVs facing such a calculated compensation are not likely to have maintained the same implicit rate of return over time. Interestingly, this finding holds for stagnant KVs as well as for dynamic small and medium KVs. This implies that sustaining the same rate of return was not only a matter of simply having been on a long-term growth path, but also a matter of having started with a large size.¹⁷

Conclusion

This paper investigates the German miners' social insurance funds, the *Knappschaften*, and their provision of members with pay-as-you-go invalidity pensions. The way they dealt with pension provision between 1854 and 1913 and the economic outcomes they produced have not yet been researched in detail. It has been shown that the miners and their employers, who, altogether, operated the mutual and non-profit funds, faced a fundamental economic problem, one that this paper assesses from a firm-level perspective: the rising relative burden from economically dependent pensioners. This economic problem is nowadays often claimed to be the main challenge to modern welfare states. During the study period, pressure on finances forced the *Knappschaften* to adjust their fiscal policy, using a mix of raising contributions and lowering the pension level.

The news here is that the nineteenth century *Knappschaften*'s business policy displays the general financial weakness of pay-as-you-go systems, but also the importance of growth. Evidence on implicit rates of return supports the conclusion that dynamic large KVs, the ones that operated the schemes in the most important and prospering mining areas (the Ruhr, Silesian, and Saar coal fields; the Mansfeld ore and Harz coal and ore fields), sustained an intergenerationally balanced policy in which differences in implicit rates of return between entrance cohorts by and large disappeared if gains in longevity are taken into account. In contrast, the majority of small and medium-sized KVs, regardless of whether they stagnated or grew in the long term, redistributed financing burdens intergenerationally towards the future. To say it in a pointed way: Since, at the start of the *Knappschaftens*' occupational insurance system, initial generations of miners were able to capitalize on their membership more extensively than was reasonable ex post, later generations of miners paid the price in the form of reduced consumption possibilities. References to contemporary observers reveal not only their worries about these intertemporal distributional effects, but also their concerns about the long-term stability of the miners' implicit intergenerational contract—thus about threats to solidarity. Thus, the problems with the PAYGO system that we usually attribute only to the modern, advanced welfare state of the second half of the twentieth century were already quite evident in the nineteenth century *Knappschaften*.

Notes

1. Still today, the *Knappschaft* is present as the second pillar of the German statutory old-age insurance. In 2005, the strictly occupational *Bundeskknappschaft* 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; Klenk, 2008, pp. 125-126).
2. However, there is literature explicitly on *Knappschaften*: Guinnane & Streb (2009) mention it in their paper on moral hazard related to the *Knappschaftens'* sick-pay benefit. An essay of Geyer (1992) provides an overview of *Knappschaft* history from the 1850s to the 1960s. Probably the most comprehensive historical account of the *Knappschaft* is Geyer (1989), which focuses on the period 1900 to 1945.
3. The Bavarian and Saxonian governments also published statistics on *Knappschaften*. However, the Bavarian document is not of the same quality as the Prussian one, and the Saxonian *Knappschaft* system worked differently from Prussia's and, hence, is not addressed in detail.
4. For Germany, the change from static to dynamic pensions is, of course, an achievement of the pension reform of 1957 (Schlegel-Voß & Hardach, 2003).
5. This is my own translation of the German original: "Hauptzweck der Knappschaftsvereine war vielen Arbeitgebern die Förderung ihrer Unternehmerinteressen. Ihrer Ansicht nach mussten die Interessen der Knappschaftsvereine und ihrer Mitglieder den Interessen der Werksbesitzer untergeordnet werden."
6. Due to the law of 1906, a second self-management body was introduced, the general assembly (*Generalversammlung*), which was intended to elect the board members and to control the balance sheets (Lauf, 2006, p. 273).
7. This is my own translation of the German original: "Ein Krebschaden ist es, an dem das deutsche Knappschaftswesen offensichtlich krankt: die Zersplitterung in viele kleine Vereine".
8. Immovable property was excluded.
9. This is my own translation of the German original: "Bei der Verwaltung der Vereine wird Rücksicht genommen auf Bildung eines angemessenen Reservefonds. Ueber die Höhe desselben, eine vielbesprochene Frage, bestehen keine gesetzlichen Bestimmungen. Viele Vereine haben den Satz von 150 Mark für jedes ständige Mitglied festgesetzt. [...]. Die Hinterlegung einer vollständigen Kapitaldeckung hält man auch nicht für erforderlich, weil der jetzigen wie der kommenden Generation genügende Sicherheit geboten wird dadurch, dass der Bergbau in Deutschland nach menschlichem Ermessen in absehbarer Zeit nicht zum Erliegen kommen und daher wie heute, so auch künftig die Verpflichtungen gegen die ältere Generation mit Hilfe der Zahlungen der jüngeren Generation würden erfüllt werden können."

10. This is my own translation of the German original: “Bei den meisten preußischen Knappschaftsvereine waren von jeher die Beiträge und Leistungen nicht nach sachgemäßen Grundsätzen festgelegt, die die dauernde Sicherstellung der Leistungen gewährleisteten. Die Beiträge waren früher fast in allen Vereinen zu niedrig festgesetzt und die Rücklagen zum Reservefonds ganz ungenügend. Nicht selten reichten die Gesamteinnahmen mancher Vereine in einzelnen Jahren nicht einmal zur Deckung der Ausgaben aus. [...]. Eine genügende Rücklage erfolgte nur bei einzelnen Vereinen. In manchen Bezirken war aber die Ansammlung erheblicher Kapitalien zur Sicherstellung der Leistungen unbedingt erforderlich, insbesondere dort, wo der Bergbau einer ungewissen Zukunft entgegenschau oder gar den Rückgang resp. Die Einstellung des Betriebes in absehbarer Zeit voraussah. In der Regel aber dachte man: „Nach uns die Sündflut“, und hielt die Beiträge möglichst niedrig. Wenn dann die Kassen vor dem Bankrott standen und die im Statut vorgesehenen Unterstützungssätze nicht mehr gezahlt werden konnten, so wurde eben eine Kürzung derselben vorgenommen.“
11. I chose to define only these three size-class intervals because nearly all KVs easily fit into one of these three classes; regarding the entire study period, each KV was put in exactly one size class and remained in it.
12. This is my own translation of the German original: “Die Tatsache, dass es unmöglich ist, mit so geringen Beiträgen wie bisher auf die Dauer so hohe Pensionen wie bisher zu gewähren, ist eben unumstößlich. Jedenfalls aber dürfte es besser sein, etwas geringere Pensionen mit voller Sicherheit für alle Zeit zu gewähren, als eine momentan günstige Lage dadurch zu erkaufen, dass man die Zukunft um so stärker belastet.“
13. The income replacement rate estimates displayed in Table 5 are definitely not comparable to rates that many present-day schemes, especially in the developed countries, provide; depending on the relative income position, the German system granted, around 1992, a net replacement rate of between 53 and 77 per cent (Börsch-Supan, 1992, p. 539). This observation can be explained by the fact that the concept of an individual’s lifetime as split into three stages—youth, employment, and retirement—had not really broken through in the nineteenth century, even not with Bismarckian old-age insurance. So, nineteenth and early twentieth century contemporaries may not have identified a pension as self-standing retirement income (because gainful employment during invalidity and family insurance had still played a major role) and, hence, had not advocated high replacement rates (Conrad, 1991; Hardach, 2003, pp. 6-7; Kaschke, 2000).
14. This is my own translation of the German original: “Dieselbe [die jeweilige Leistungsfähigkeit eines KV, Anm. des Verf.] beruht nicht darauf, dass etwa in einem Jahre oder während einer Reihe von Jahren die dann gerade auszahlenden Pensionen aufgebracht werden können. Die Knappschaftsvereine sind vielmehr nur dann fähig, zu irgendeiner Zeit Pensionen in einer bestimmten Höhe zu leisten, wenn zugleich rechnungsmässig feststeht, dass sie stets die gleichen

15. The data situation is quite good, but not optimal. The Prussian KV statistics offer a range of statistical information on KVs, but also lack some that are important for this paper. So, until 1913, I lack data on the average age at which a miner first joined a KV and, until 1899, lack data on the average length of service, the average pension duration (number of years for which a pension was paid), and the average age at death of the invalidity pensioners.
16. Not displayed are implicit rates of return for entrance cohorts 1886 and 1891 that allow especially for the effect of war and post-war inflation. Basically, rates fit into the picture since they are much lower for almost all KVs than rates depicted above. So, the secular trend of diminishing rates of return can be traced beyond the year 1913.
17. A final note on widows' and orphans' pension is necessary. I have not taken them into account here. However, because of the fact that widows' pensions usually made up 50 per cent of the invalidity pension, we simply have to double the longevity compensation in order to get an impression of how many years a miner's widow had to receive her pension if her husband died after five years of retirement

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