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On the Historical Roots of the Modern Welfare State: The *Knappschaft* Statistics of 1861 to 1920 as a Source for Quantitative Historical Social Research

Tobias A. Jopp [*]

Abstract: *»Zu den historischen Wurzeln des modernen Wohlfahrtsstaates: Die Knappschaftsstatistiken der Jahre 1861 bis 1920 als Quelle quantitativer historischer Sozialforschung«.* This article introduces the *Knappschaft* statistics as a basic source for quantitative data on a very important topic in historical social research, namely the rise of the welfare state. Scholars who seek to embark upon historical social research in that direction require both qualitative and quantitative data. Exploring data sources and making data available for general use thus is crucial to systematic research and scholarly discourse. For the period 1861 to 1920, the *Knappschaft* statistics document the operation of the various German *Knappschaftsvereine* as the carriers of miners' occupational social insurance at the time. Data on the various *Knappschaften* are quite rich enabling us to use them as a "historical laboratory" not merely to study the welfare positions of and social relations in a particular societal class in a particular period, but to explore more general questions related to the roots of modern welfare states, their functioning, and the challenges they face. To stress this point, I combine the concise overview of the *Knappschaft* statistics with a straightforward application to the question of the consequences of aging in a pay-as-you-go pension system.

Keywords: aging, Knappschaft, pension level, Prussia, social insurance, statistics, welfare state.

1.   Introduction

Scholars who seek to embark upon historical social research require both qualitative and quantitative data. Exploring data sources and making data available for general use thus is crucial to systematic research and scholarly discourse. In this regard, this article's intention is to introduce the *Knappschaft* statistics as a basic, yet less known, source for quantitative data on a very important topic in historical social research, namely the rise of the welfare state and its basic challenges.

Several statistics frameworks were systematically compiled between 1861 and 1920 to document the operation of the various German *Knappschaftsvereine* ("KVs" in the following) as carriers of miners' occupational social insurance. These miners' relief societies trace their roots some 750 years back when they originally emerged as religious and charitable brotherhoods of the mediaeval miners of the Harz region and Erz Mountains (both in central Germany). Around the middle of the nineteenth century, KVs existed in many German states, where mining of coal or ore existed; among those states, Bavaria, Prussia and Saxony were the most important ones in terms of the number of operating KVs, as well as in terms of the number of covered miners. It was especially around this time that the KVs were re-defined as what might be called the earliest historical example of a social insurance scheme insuring participants against income losses due to invalidity (lasting incapacitation for work), survivorship, and sickness (temporary incapacitation for work). Conventional wisdom links up this kind of collective provision against fundamental life risks with Bismarckian worker insurance introduced between 1883 and 1889. In fact, the KVs had already been based on principles commonly associated with social insurance – mandatory contributions by employees and employers, joint self-government of both parties, and the existence of an implicit generational contract – before, and anticipated the major principles of Bismarck's system (Tampke 1982).

As we shall see below, data on the various KVs are quite rich enabling us to use the KVs as a "historical laboratory" not merely to study the welfare positions of and social relations in a particular societal class in a particular period, but to explore more general questions related to the roots of modern welfare states, their functioning, and the challenges they face. To stress this point, I combine the concise overview of the *Knappschaft* statistics with a straightforward application to the question of the consequences of aging in a pay-as-you-go pension system.[1] Prussian, but also Bavarian KVs were financed that way. In combination with the fact that among the main benefits offered were pen-

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[1] For a discussion of the set of problems, exemplarily see Cutler et al. (1990), Schmähl (2001), and Börsch-Supan and Ludwig (2010).

sions to invalids, widows and orphans, this is the necessary pre-condition for preparing an experience report out of history on that topic. Moreover, the KVs' history shows that they clearly were subject to aging over time.[2]

This article mainly adds to two strongly interrelated fields of research: (i) the historical literature on the rise of the welfare state(s) and (ii) the historical literature especially on the long-term relationship between population aging and the financing of pension and health care programs. Recent as well as classic contributions to the former include, for example, Mommsen (1981), Hennock (1982, 1987, 1990, 2007), Lindert (1994), Eghigian (2000), Flora and Heidenheimer (2003), Gladstone (2008), Nijhof (2009), Companje et al. (2009), Ritter (2010), Reimat (2012), and Harris (2012). Making use of historical data, Cutler and Johnson (2004), in particular, test conflicting hypotheses on why the "social insurance state" emerged (such as the "Leviathan theory", the "demographic heterogeneity theory", or the "political legitimacy theory"). Studies regarding the latter strand of literature include, for example, Johnson (1984), Diebolt and Reimat (1997), Hardach (2003), Pearson (2003). Complementary to the studies mentioned above, Guinnane (2011) and Galor (2012) provide recent insights into the "demographic transition" as the transition from high to low fertility and, respectively, low to high life expectancy. Due to the KVs' nature as occupational and (kind of) mutual insurers, this article also links up with, for example, Hannah (1986), who investigates the emergence of occupational pensions in Britain, and the body of literature on mutual relief societies outside Germany (e.g., Beito 2000; Emery and Emery 1999; Murray 2006; Van der Linden 1996).

The article proceeds as follows. Section 2 introduces the *Knappschaft* statistics covering the formative period of the German welfare state, 1861-1920. The prime focus lies on the statistics on Prussian KVs, but the ones on Bavarian and Saxon KVs are briefly touched as well. Section 3 outlines how part of the data may be applied to assess the KVs' experience with aging memberships. Section 4 concludes the paper.

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[2] This article cannot give a comprehensive account of the KVs' economic history in the second half of the nineteenth and the early twentieth century, and, in particular, not of the structure and style of KVs. A body of literature has recently emerged answering such principle questions as to "how did the KVs work?" or "what was the typical insurance contract like?" (Guinnane and Streb 2011; Guinnane, Jopp and Streb 2012; Jopp 2011a, 2011b, 2012). For more detailed information on the KVs, one may consult this literature.

2.   The *Knappschaft* Statistics – A Description

2.1   The Relatively Best-Documented Case: Prussian *Knappschaften*

Basically, there are three reasons why we should focus on *Prussian* KVs in the first instance: To start with, the Prussian KVs were the first ones to be transformed into social insurance providers formally acting on behalf of the government. This happened during the Prussian mining reform of 1851-1865. All German states that committed themselves to the Prussian tradition of mining sector regulation imitated the Prussian General Mining Law of 1865, including the paragraphs on how to regulate KVs (e.g., Bavaria in 1869); there were only few states that committed themselves to the different regulatory tradition of the Kingdom of Saxony. Insofar, willingly or unwillingly, Prussia set the standard. Secondly, as of the middle of the nineteenth century, Prussia had emerged as the German core mining region with KVs located there accounting for around 90 percent of all German miners; this share remained stable over the whole period under consideration. Thirdly, the Prussian *Knappschaft* statistics show the comparatively highest degree of informational detail as measured by the number of different variables reported.

The Prussian *Knappschaft* statistics, officially entitled the *Statistik der Knappschaftsvereine des preussischen Staates*, had been compiled and edited the first time in 1855 by Rudolf von Carnall, with permission of the Prussian Department of Mining, Metallurgy and Salines (*Ministerial-Abtheilung für Berg-, Hütten- und Salinenwesen*). He edited four further volumes (von Carnall 1854-1858). These, as well as all subsequent ones, were published as part of the *Zeitschrift für das Berg-, Hütten- und Salinenwesen in dem preussischen Staate*. Of those initial five volumes, only the first reports data on the individual KV-level for the year 1852, when the KVs were not yet reformed, but still subordinated under the so-called direction principle, which had once installed the mercantilist state's bureaucracy as the sole authority running miners' funds (Jopp 2012b, 44-5). From 1859 on, the *Knappschaft* statistics were compiled and edited by three administrative bodies, namely the Prussian Ministry of Trade, Commerce and Public Works (*Ministerium für Handel, Gewerbe und öffentliche Arbeiten* 1859-1878), the Prussian Ministry of Public Works (*Ministerium für öffentliche Arbeiten* 1879-1889) as a spin-off of the former, and, respectively, the Prussian Ministry of Trade and Commerce (*Ministerium für Handel und Gewerbe* 1890-1922). Compiled were the business reports that KVs were obliged to prepare and forward to the administration. In fact, all volumes issued since 1862, when post-reform KV-level data were reported the first time, are employable for systematic quantitative research; each volume reports data on the preceding year.

The appeal of the Prussian KV statistics basically stems from the fact that it explicitly reports data on many aspects of miners' funds' operations (such as membership composition and financing streams) on the KV-level, and not merely on the aggregate. To the best of my knowledge, comparably extensive statistical frameworks addressing, say, all the sickness relief and other relief funds that came into existence after 1845, when the Prussian Industrial Code (*Gewerbeordnung*) was enacted, or after 1854, when the Law on Industrial Provident funds (*Gesetz betreffend die gewerblichen Unterstützungskassen*) came into being, are not available.

Structurally, we can order the data reported on the KV-level according to three main "reporting instruments", namely a KV's "profit and loss statement", a KV's "asset balance", and a KV's "membership balance"; the following three sub-sections will go through these instruments. Within each of these three problem areas data are ordered according to the spatial structure of KVs. In all, 103 different KVs operated in Prussia over the period 1861-1920. Each KV was located in one of five different so-called *Oberbergamtsbezirke* (mining administration regions), named after the cities, where the offices were: Bonn (comprising the Saar and Aachen coal-fields), Breslau (comprising the Upper and Lower Silesian coal-fields), Clausthal (comprising the Harz coal- and ore-fields), Dortmund (comprising the Ruhr coal-fields), and Halle (comprising part of the important Saxon coal- and ore-fields). These mining administration regions, of which we will find complements in Bavaria and Saxony, were the administrative fundament of Prussian mine regulation. They should not be confused with general governmental districts (*Regierungsbezirke*), though.

2.1.1 Profit and Loss Statement

What I call the KVs' "profit and loss statement" should, actually, not be regarded as a statement complying with formal accounting standards. Reported for each KV are revenue items on the one hand and expenditure items on the other. Table 1 provides an overview of those items. I encoded main revenue categories by "R1" to "R5" and main expenditure categories by "E1" to "E6".

Before taking a closer look at the respective items, some peculiarities should be addressed regarding the way data are presented in the statistics: Firstly, all monetary figures are denominated in Prussian thaler until 1874 and in mark thereafter. Secondly, until 1907, a couple of items were separately reported for two basic categories of membership, namely for the so-called "established" and "unestablished" miners (*ständige* and *unständige Bergleute*). Originally, this distinction, which not every KV knew, had been created to separate full-time workers (established) from part-time workers (unestablished); the former were equipped with more rights such as access to a more extensive benefit package (in terms of the sheer amount as well as the different sorts of benefits) or more voting rights. Since regulations prescribed compulsory membership, and thus

forced a KV into contracting with every miner who was employed in its respective insurance area, this distinction might have been some kind of risk policy instrument, but not an instrument to exclude miners from membership at all. This is because KVs usually specified that those who wanted to become an established miner were to meet certain criteria (e.g., be of age 20/25 to 40/45; be of moral integrity; be of good, certified health). Every miner who did not meet those criteria was classified unestablished. This distinction, claimed unjust by many a workers' representative, was no longer retained after 1907. Thirdly, the same regulatory reform that abolished the opportunity of discrimination introduced an accounting separation, too. While, until 1907, KVs had been running a kind of compound insurance scheme, in which exactly one contribution payment was charged per miner for the whole package of invalidity, survivorship and health-related benefits, they were required to run their pension and sickness insurance sections as if they were two self-standing businesses from then on. As a consequence, we find that starting in 1908 revenues, expenditures, assets and memberships were separately reported for the pension and the sickness insurance sections. Fourthly, and finally, there are obvious reporting inconsistencies. Some variables were not reported over the full observation period, or the degree of detail changed here and there.

Along with each item, such as "contributions by employers", some additional information is given in the table: on the hand, the run time of each variable (e.g., reported over the period 1861 to 1866, or "1861/66") and, on the other hand, whether the respective item was only relevant, after 1907, for the pension insurance section or, respectively, for the sickness insurance section as indicated by a superscript "a" or "b". If not indicated this way, the variable is reported for both sections.

Now let us take a look at revenues and expenditures. KVs evidently relied on several income sources. First, and most importantly, there were social insurance contributions by miners and their employers (R1.1 to R1.7), usually charged as a fixed amount per capita (and, maybe, per class of seniority and income); if we explored the data in more depth, we would find that contributions usually accounted for 75 to 90 percent of a KV's income.

Furthermore, there were some sorts of fees to be paid (R2.1 to R2.4). One fee was linked with the act of joining a KV; a second was due as corrective measure in case of misbehavior; and a third was due if a miner married; his KV would then have processed administrative affairs. What I translate with "acknowledgement fees" (*Anerkennungsgebühren*) were a means for an insurant who faced an interruption of employment to keep up entitlements he had

already accumulated; in other words, paying those fees instead of regular contributions did not mean to earn incremental entitlements on top.[3]

Table 1: Schematic Profit and Loss Statement

Revenues	Expenditures
(R1) Contributions	*(E1) Pension benefits*
(R1.1) By established miners (1861/88)	(E1.1) Semi-invalidity (1861/88)
(R1.2) By unestablished miners (1861/88)	(E1.2) Full invalidity (1861/1920)
(R1.3) By employers (1861/1920)	(E1.3) Surviving widows (1861/1920)
(R1.4) By miners on leave (1867/88)	(E1.4) Surviving orphans (1861/1920)
(R1.5) By sick miners (1867/88)	(E1.5) Widows' compensation after remarriage[a] (1908/20)
(R1.6) By miners (1889/1920)	(E1.6) Miscellaneous[a] (1908/20)
(R1.7) Arrearage, preceding year (1908/20)	*(E2) Health-related benefits*
(R2) Fees	(E2.1) Physicians' salary (1861/1920)
(R2.1) Marriage fees (1861/66)	(E2.2) Medical Treatment (1861/1920)
(R2.2) Joining fees (1861/1920)	(E2.3) Daily sick pay (1861/1907)
(R2.3) Punishment fees (1861/1907)	(E2.4) Sick pay if treated at home[b] (1908/20)
(R2.4) Acknowledgement fees[a] (1908/20)	(E2.5) Sick pay if treated in hospital and dependants eligible for benefits exist[b] (1908/20)
(R3) Capital income	(E2.6) Sick pay if treated in hospital and dependants eligible for benefits do not exist[b] (1908/20)
(R3.1) Interest (1861/1907)	(E2.7) Payments to women in childbed[b] (1908/20)
(R3.2) Interest on paper holdings (1908/20)	(E2.8) Hospital treatment[b] (1908/20)
(R3.3) Interest on bank deposits (1908/20)	*(E3) Miscellaneous benefits*
(R3.4) Rent (1861/1907)	(E3.1) Funeral pay (1861/1907)
(R3.5) Net yield from own establishments (1909/20)	(E3.2) Funeral pay (death of invalid, 1908/20)
(R4) Other revenue sources	(E3.3) Funeral pay (death of dependant, 1908/20)
(R4.1) Miscellaneous (1861/1920)	(E3.4) Extraordinary support (1861/1907)
(R4.2) Deductions because of wage increases (1867/88)	(E3.5) Education support (1861/1907)
(R4.3) Extraordinary sales (1867/1907)	(E3.6) Compensation of foreigners[a] (1908/20)
(R4.4) Donations (1867/1907)	*(E4) Operating costs*
(R4.5) Compensation payments by Reich insurance carriers and other KVs[b] (1908/20)	(E4.1) Administrative cost (1861/1920)
(R5) Net deficit (1861/1920)	(E4.2) Miscellaneous costs (e.g., hospital construction (1861/1920)
	(E4.3) Arbitration court use[a] (1908/20)
	(E4.4) Maintenance of buildings[a] (1908/20)
	(E4.5) Interest on debt (1909/20)

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[3] In my opinion, it is likely that "contributions by the ones on leave" (R1.4) were, in essence, such acknowledgement fees. Unfortunately, as can be seen, there is a reporting inconsistency since either variable is not reported for the period 1889 to 1907.

Table 1 continued...	
	(E4.6) Taxes (1909/20)
	(E4.7) Medical examinations before joining the KV[a] (1909/20)
	(E5) Refunds to other KVs
	(E5.1) Invalidity pensions[a] (1908/20)
	(E5.2) Widow's pensions[a] (1908/20)
	(E5.3) Widows' compensation after remarriage[a] (1908/20)
	(E6) Net surplus (1861/1920)

Notes: Quantities measured by 31st December. A superscript "a" denotes items only relevant, after 1907, regarding the pension insurance section. A superscript "b" denotes items only relevant, after 1907, regarding the sickness insurance section.
Sources: See text.

Additional income sources were interest on assets, rent, and earnings from own establishments, such as hospitals, or some rather irregular revenues such as donations and extraordinary sales of assets, e.g., a building (R.3.1 to R4.5).[4] Of all these miscellaneous items, interest income was relatively most important.

The expenditure side illustrates quite well the comprehensive benefit package the KVs offered. Some benefits, such as the three types of pensions for invalids and survivors (E1.1 to E1.4) as well as daily sick pay, basic healthcare costs, and funeral subsidies (E2.1 to E2.6, and E2.8 and E3.1 to E3.3), had to be provided by every KV; remaining benefits, such as "education support" for parents (mostly tuition fees) were voluntarily offered. Regarding pensions, some KVs distinguished for some time between semi- and full invalidity. While the former case went along with being still capable of working as a miner, albeit not in the same dangerous position as before, full invalidity meant to be incapable, from the perspective of the system, of working as a miner for the rest of one's life; this, however, did not rule out the possibility of earning a wage in another sector of the economy, while receiving an invalidity pension from a KV.

Beyond benefit expenditures, the statistics also informs about pure operational expenses. Until 1907, the statement was badly undifferentiated in that all sorts of cost were only reported as either administrative expenses – mainly labor costs – or the remainder – mainly maintenance of buildings. After the accounting reform, the statement became much more informative, especially with regard to the KVs' pension insurance section.

What is called "refunds to other KVs" (E5.1 to E5.3) emerged whenever a miner had changed his workplace *and* the KV that insured him, because the new workplace was situated in another KV area. However, there had to be a

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4   Gathered under "miscellaneous revenues" (R4.1), were, for example, commissions or all items that were not consistently reported explicitly over the whole period (e.g., marriage fees after 1867, or punishment fees after 1908).

bilateral contract between two KVs stating that the one KV would settle pension claims for the time the miner was part of its membership and the other would act accordingly.[5]

Finally, counting revenues against expenditures, KVs could have either realized a net surplus, which happened more frequently, or a net deficit (R5 and E6). Although KVs were not-for-profit organizations, they often charged more contributions than were necessary to settle claims. However, since this only became clear at the end of the year, *ex post*, reserves were in fact accumulated and ready to be used as a financial buffer in times of trouble.

2.1.2 Asset Balance

Let us turn to the KVs' asset balance as illustrated by Table 2. Analogous to what I have done above, I encoded items on the left-hand side – assets – with "A" and those on the right-hand side – liabilities – with "L".

KVs were definitely equipped with assets. A great many did actually not own buildings (A4) themselves, and often KVs did not even report movable assets (A5). But almost every KV in almost every year of operation reported monetary assets generated from net surpluses in past years.[6] The single-most important productive investment was interest-bearing assets (A3).[7] In comparison, the amount of cash holdings, bank deposits and miscellaneous assets (e.g., receivables) was rather low.

There is an asset category – "reinsurance deposit" – that deserves special attention. Recall the regulatory reform of 1906 that led to the abolishment of the established/unestablished status and that prescribed the institutional separation of pension insurance from health insurance operations. The same reform also prescribed a modified pay-as-you-go method to be applied by all KVs, the so-called *Rentenwertumlageverfahren* ("present value pay-as-you-go scheme", one might say, versus "current value pay-as-you-go scheme"). In essence, KVs were obliged to accumulate reserves so such that all pensions, granted from

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[5]   Note that the bottom line among KVs was that a miner turning over to another KV lost his entitlements already accumulated. Actually, this was a problem of portability of entitlements, which was often solved bilaterally, but which was coherently addressed by regulations not before 1907.

[6]   At the beginning of each volume, it is reported which type of building a KV owned. For the years 1867 to 1907, the statistics reports the number of hospitals, schools (for the miners children), and administrative buildings. For the years 1908 to 1920, it reports the number of hospitals, infirmaries, pharmacies, schools, orphanages, and administrative buildings.

[7]   Unfortunately, the statistics do not report of which type they were. Though, according to Jüngst (1913, 266-9), we get to know that the larger KVs usually held a mix of mortgages, Prussian government bonds, German *Reich* bonds, municipal bonds, and other loans.

1908 on, would be pre-funded to the amount of their expected duration (i.e., their present values) in the same year they were due the first time.[8]

Table 2: Schematic Asset Balance

Assets	Liabilities
(A1) Capital assets (1861/66)	(L1) Debt on immovable property (1867/1920)
(A2) Cash holdings (1867/1920)	(L2) Other debt (1867/1920)
(A3) Interest bearing assets (1867/1920)	*(L3) Net debt (1867/1920)*
(A4) Immovable property (1867/1920)	
(A5) Movables (1867/1920)	
(A6) Miscellaneous assets (1861/1920)	
(A7) Bank deposits (1908/20)	
(A8) Reinsurance deposit[a] (1908/20)	
(A9) Net assets (1861/1920)	

Notes: Quantities measured by 31st December. A superscript "a" denotes items only relevant, after 1907, regarding the pension insurance section.
Sources: See text.

Formally, the KVs had two choices as how to deal with this requirement: First, raise contributions adequately and directly invest net surpluses in interest-bearing assets to pre-fund pension liabilities; or, second, to pay annual contributions to a reinsurance fund, created for this purpose, exactly to (half) the amount of the present value of all pensions granted in 1908 or later; the reinsurance organization would then have step by step transferred back to a KV the amount of pension payment annually required. In fact, both alternatives were economically nearly equivalent regarding the amount of contributions to be additionally charged. In the second case, though, KVs would not have invested on their own, but would have outsourced part of their investment decisions and asset management. So, in case a KV decided to join this reinsurance fund and had granted at least one pension in 1908, we find a reinsurance deposit reported.[9]

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[8] An example seems helpful here. Imagine a KV at the beginning of 1908 consisting of exactly three members, namely Friedrich, Wilhelm, and Otto. Assume Otto became invalid in 1907 and Wilhelm became invalid, and eligible for an invalidity pension, right at the beginning of 1908, while Friedrich would regularly work and contribute over that year. Further assume the KV expected Wilhelm to live for another 15 years, thus until the end of 1923, and Otto at least to survive 1908. According to the new regulations, the KV had to specify Friedrich's contributions due in 1908 such that they would exactly cover current expenditures on Otto's pension in 1908 (i.e., regardless of how long he might still live) *and* half of all expected expenditures on Wilhelm's pension over the period 1908-1923 (i.e., the pension's present value discounted to the beginning of 1908). Although this example does not include survivors, their pensions were to be pre-funded in the same fashion, albeit for their full amount. Only in the case that a miner had been a member in more than one KV was his pension to be prefunded in full as well.

[9] Originally the reinsurance organization was named Knappschaftliche Rückversicherungsanstalt a.G. Charlottenburg, but re-named Knappschaftlicher Rückversicherungsverband in

Finally, the liability statement is also rather undifferentiated. A KV might have run up mortgages on its immovable property (L1) or took out other loans (L2). However, the frequency of claiming liabilities was rather low, too.

2.1.3 Membership Balance

All in all, the statement on membership composition occupies most of the space in the statistics.[10] I think it is appropriate here to distinguish "membership stock quantities" ("MSQ"), as measured at a particular point in time (either the first of January, or the 31st of December), from "membership flow quantities" ("MFQ"), as measured by cumulating incidences over the whole year such as deaths by membership category. As with the KVs' profit and loss statement and asset balance, documented membership information shows some inconsistencies.

Table 3 displays membership information by four categories of stock quantities on the left-hand side – overall contributors, established contributors, unestablished contributors, and pensioners – and by seven flow quantities on the right-hand side – inflow of overall contributors, outflow of overall contributors, outflow of established contributors, outflow of unestablished contributors, inflow of pensioners, outflow of pensioners, and the number of claimed sick days.

Reported, for example, are such stock quantities as the number of contributors (established, unestablished, and, consequently, overall) by subsector (MSQ 1.2, MSQ 2.2, and MSQ 3.2), enabling us to assess the production structure underlying each KV, or the number of established and, respectively, overall contributors by age-group (MSQ 1.3, MSQ 2.3, and MSQ 2.5), enabling us to derive the age structure of KVs. Together with age-related data on pensioners, such as age-group sizes (MSQ 4.6, MSQ 4.7, and MSQ 4.8) or information on the average pension duration and effective age at retirement (MSQ 4.15, MSQ 4.16, and MSQ 4.17), it is definitely possible to assess the KVs' experience with aging. It is a bit uncomfortable, though, that age-group sizes were not reported consistently over time; note the changes of the age categories from 1888 to 1889 and from 1907 to 1908.

1916. It was also in that year that membership became compulsory for all Prussian KVs. The reinsurance organization was shut down in 1923 eventually, when the Reichsknappschaft was installed by merging all remaining German KVs into one national social insurance fund.

[10] Not displayed in the following is the statement on personnel. Each KV was run by its own board consisting half and half of miners' and employers' representatives. Besides, the board was supported by a number of the so-called Elders, respectable people recruited from both the working membership and retirees, fulfilling honorary tasks such as controlling the sick or keeping membership lists up-to-date. Consequently, the statistics reports the number of board members and Elders, but also the number of KV physicians, orderlies, administrative staff, and an unspecified rest. Since 1908, we also get to know the number of pharmacists, and the administrative staff is differentiated from then on in clerks and actuaries.

Table 3: Membership Information

Membership stock quantities	Membership flow quantities
(MSQ1) Overall contributors	*(MFQ 1) Inflow of contributors*
(MSQ1.1) Number (1861/1920)	(MFQ 1.1) Established ones (1861/1907)
(MSQ1.2) Number by subsector (1908/20; hard coal, brown coal, iron ore, miscellaneous ores, halite, stones, steelworks, zinc/ lead/ copper/ silver ore processing, alum and vitriol processing, tar and paraffin processing, salines)	(MFQ 1.2) Unestablished ones (1861/88)
(MSQ1.3) Number by nine age-groups (1908/20; under 20, 21-25, 26-30, 31-35, 36-40, 41-50, 51-60, 61-70, 71 and older)	(MFQ 1.3) Overall contributors[a] (1861/1920; thereof acknowledgement fee payers over 1908/20)
(MSQ 1.4) Number of acknowledgement fee payers[a] (1908/20; thereof participants in war over 1914/19)	(MFQ 1.4) Sick members[b] (1861/1920; due to accident and due to other reason)
(MSQ 1.5) Number of participants in war (1914/19)	*(MFQ 2) Outflow of contributors*
(MSQ 1.6) Number of sick members[b] (1908/20)	(MFQ 2.1) Because of having become eligible for invalidity[a] (1908/20; thereof due to work accident and, for 1914/19, due to war)
(MSQ 2) Established contributors	MFQ 2.2) Overall deaths[a] (1908/20; thereof due to work accident and, for 1914/19, due to war)
(MSQ 2.1) Overall number (1861/1907)	(MFQ 2.3) Outflows for other reasons[a] (1908/20)
(MSQ 2.2) Number by subsector (1861/1907; hard coal, brown coal, iron ore, miscellaneous ores, halite, stones, steel-works, zinc/ lead/ copper/ silver ore processing, alum and vitriol processing, tar and paraffin processing, salines)	(MFQ 2.4) Outflow of acknowledgement fee payers[a] (1908/20; eligible for invalidity, death, other reasons)
(MSQ 2.3) Number by six age-groups (1867/88; under 16, 16-25, 26-35, 36-45, 46-55, 56 and older)	(MFQ 2.5) Outflow of sick members[b] (1861/1920; due to death, due to recovery, and due to other reason)
(MSQ 2.4) Number of suspended members (1889/1907)	*(MFQ 3) Outflow of established contributors*
(MSQ 2.5) Number by ten age-groups (1889/1907; under 16, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56 and older)	(MFQ 3.1) Eligible for invalidity (1861/1907)
(MSQ 2.6) Number of sick members (1861/1907)	(MFQ 3.2) Discharges from membership (1861/1907)
(MSQ 3) Unestablished contributors	(MFQ 3.3) Deaths (1861/1907; thereof by work accident)
(MSQ 3.1) Number (1861/1907)	(MFQ 3.4) Deaths by six age-group (1867/88; under 16, 16-25, 26-35, 36-45, 46-55, 56 and older)
(MSQ 3.2) Number by subsector (1861/1907; hard coal, brown coal, iron ore, miscellaneous ores, halite, stones, steel-works, zinc/ lead/ copper/ silver ore processing, alum and vitriol processing, tar and paraffin processing, salines)	(MFQ 3.5) Deaths by ten age-groups[a] (1889/1920; under 16, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56 and older)
(MSQ 3.3) Number of sick members (1861/1907)	*(MFQ 4) Outflow of unestablished contributors*

Table 3 continued...	
(MSQ 4) Pensioners	(MFQ 4.1) Discharges from membership (1861/88)
(MSQ 4.1) Number of invalids (1861/1907; for both full- and semi-invalids)	(MFQ 4.2) Eligible for invalidity (1861/1907)
(MSQ 4.2) Number of overall invalids[a] (1908/20; thereof invalid due to work accident and, for 1914-1919, due to war)	(MFQ 4.3) Deaths (1861/1907; thereof by work accident)
(MSQ 4.3) Number of widows[a] (1861/1920)	*(MFQ 5) New applications to pensioner status*
(MSQ 4.4) Number of orphans[a] (1861/19020; for both fatherless and mother- and father-less)	(MFQ 5.1) Invalids from established membership (1861/1907; for both full- and semi-invalidity)
(MSQ 4.5) Average age at becoming eligible for invalidity[a] (1861/1920; for both full- and semi-invalidity)	(MFQ 5.2) Invalids from unestablished membership (1861/1907; for both full and semi-invalidity)
(MSQ 4.6) Number of invalids by nine age-groups[a] (1867/1920; under 30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, 66 and older; for both full- and semi-invalids)	(MFQ 5.3) Invalids due to accident (1908/20) and, for 1914/19, due to war[a]
(MSQ 4.7) Number of widows by ten age-groups (1867/1907; under 20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61 and older)	(MFQ 5.4) Widows[a] (1861/1920; for 1914/19, due to war)
(MSQ 4.8) Number of widows by nine age-groups[a] (1908/20; under 26, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61 and older)	(MFQ 5.5) Orphans[a] (1861/1920; for both fatherless and mother- and fatherless; for 1914/19, due to war)
(MSQ 4.9) Orphans receiving education support (1867/1907)	(MFQ 5.6) Invalids by nine age-groups[a] (1868/1920; under 30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, 66 and older; for both full- and semi-invalids)
(MSQ 4.10) Invalids receiving an accident pension from the Knappschafts-Berufsgenossenschaft (1889/1907; for both full- and semi-invalids)	(MFQ 5.7) Widows by ten age-groups[a] (1867/1920; (under 20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61 and older)
(MSQ 4.11) Widows receiving an accident pension from the Knappschafts-Berufsgenossenschaft (1899/1907)	*(MFQ 6) Outflows of pensioners*
(MSQ 4.12) Orphans receiving an accident pension from the Knappschafts- Berufsgenossenschaft (1889/1907)	(MFQ 6.1) Deaths of orphans (1861/66)
(MSQ 4.13) Average length of service at the time of becoming eligible for invalidity[a] (1900/20; for both full- and semi-invalidity)	(MFQ 6.2) Discharges of orphans because of having reached the age of fourteen[a] (1861/66; 1908/20)
(MSQ 4.14) Average length of service among inflowing widows' husbands[a] (1900/20)	(MFQ 6.3) Deaths of invalids[a] (1861/1907: for both full- and semi-invalidity; 1908/20: due to accident, and, for 1914/19, due to war)
(MSQ 4.15) Average pension duration among those invalids that died over the course of the year[a] (1900/20; for both full- and semi-invalidity)	(MFQ 6.4) Outflow of invalids for other reasons (1861/1907; for both full- and semi-invalidity)
(MSQ 4.16) Average pension duration among those widows that died over the course of the year[a] (1900/20)	(MFQ 6.5) Invalids re-integrated into working membership[a] (1908/20)

Table 3 continued...	
(MSQ 4.17) Average biological age among inflowing invalids[a] (1868/1920)	(MFQ 6.6) Deaths of widows[a] (1861/1920; for 1914/19, due to war)
(MSQ 4.18) Average biological age among re-integrated invalids[a] (1908/20)	(MFQ 6.7) Outflow of widows because of remarriage[a] (1861/1920)
(MSQ 4.19) Average pension duration among re-integrated invalids[a] (1908/20)	(MFQ 6.8) Outflow of widows due to other reason[a] (1908/20)
(MSQ 4.20) Average biological age among the stock of widows[a] (1908/20)	(MFQ 6.9) Outflows of Orphans (1861/1907)
(MSQ 4.21) Average biological age among inflowing widows[a] (1908/20)	(MFQ 6.10) Deaths of orphans[a] (1908/20)
	(MFQ 6.11) Deaths of invalids by nine age-groups[a] (1867/1907; under 30, 30–35, 36–40, 41–45, 46–50, 51–55, 56–60, 61–65, 66 and older; for both full- and semi-invalidity)
	(MFQ 7) Claimed sick days
	(MFQ 7.1) Number of sick days established miners took off (1861/1907; reimbursed with sick pay or physician's cost only)
	(MFQ 7.2) Number of sick days unestablished miners took off (1861/1907; reimbursed with sick pay or physician's cost only)
	(MFQ 7.3) Through sick pay while staying at home[b] (1908/20)
	(MFQ 7.4) Through sick pay while cured at hospital[b] (1908/20)
	(MFQ 7.5) Without sick pay while cured at hospital[b] (1908/20)

Notes: Overall numbers of contributors and pensioners are reported by January 1st and December 31st. All other stock quantities measured by 31st December. Regarding both established and unestablished working members, the statistics made, until 1889, a distinction between fully contributing members and those who were suspended. A superscript "a" denotes items only relevant, after 1907, regarding the pension insurance section. A superscript "b" denotes items only relevant, after 1907, regarding the sickness insurance section. After 1908, the KV statistics reports working members as well as invalids by sex.
Sources: See text.

As the number of reported variables shows, the degree of detail of the statement on flow quantities is even higher. For example, the statistics generally specify outflows of working members as caused (i) by death – and whether death was caused by accident or disease (and, for the period 1914-1919, by participation in war) –, (ii) by having become eligible for an invalidity pension, or (iii) by another reason; actually, the latter "catch-the-rest" category mainly accounted for those contributors that left their KV to join another one, or to quit the mining sector forever. Outflows of invalids were caused by death, of course, or by re-integration into working membership; the frequency of re-integrations was, however, very low. Besides death, widows would also have

quit membership if they re-married. Finally, orphans were supported with a pension until the age of fourteen.[11]

Taking into account that some KVs survived over the full period of 1861-1920, but others ceased operation sometime in between or came into operation only sometime after 1861, there are 4,450 "KV years" to be observed overall.

2.2   Other Important Statistics: Bavaria and Saxony

Bureaucracies in Bavaria and Saxony were also engaged in compiling data on the KVs there. First, there is the Bavarian KV statistics, or *Statistik der Knappschaftsvereine im bayerischen Staate*, which is to the best of my knowledge only available from 1871 on (Oberbergamt München 1871-1921). Thus, it was started to be issued two years after the Bavarian mining reform.

All in all, the Bavarian KV statistics document the operation of all the 56 different KVs that operated in the period 1871-1920 in a way quite similar to what Prussians did. KVs may be ordered by certain mining administration regions (*Berginspektionsbezirke* in this case) as well, namely Bayreuth, Munich, Regensburg (the latter dissolved in 1882), and Zweibrücken. In fact, complementing a data set on Prussian KVs with information on Bavarian ones would add additional 1,639 observable KV years per variable.

Finally, the Saxon KV statistics was published as part of the *Jahrbuch für den Berg- und Hütten-Mann* (Königliches Finanzministerium Sachsen 1870-1872) or, respectively, the *Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen* (Königliches Finanzministerium Sachsen 1873-1921). The 1870 volume actually reports data on the year 1868 when the Saxons conducted their own mining reform including a reform of KV regulations.[12]

In all, 93 different KVs were in operation over the full period 1868-1920 or, at least, for some years or decades yielding 1,097 observable KV years.[13] In contrast to Prussian and Bavarian KV regulation, Saxony strictly separated into pension funds and sickness societies. From the perspective of the Saxon KV statistics, a KV was a fund that insured against invalidity and survivorship. Consequently, societies insuring miners against sickness were not counted as a *Knappschaft*. Beyond that, Saxon KVs were strictly separated by product (hard coal, brown coal, and ores).[14]

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[11]   Note that provision for surviving dependants became part of Bismarckian worker insurance not before 1911.

[12]   It is possible to obtain some data on Saxon KVs for several decades prior to 1868. The degree of informational detail, however, increased notably with the first post-reform volume.

[13]   This rather low number of observable KV years is due to the fact that all but two KVs were merged into one large pension fund in 1890, the *Allgemeine Knappschafts-Pensionskasse Sachsen*.

[14]   Bavarians and Prussians did not know such a distinction by rights.

3. Application: The *Knappschaften*'s Aging Memberships

3.1 Historical Evidence on Aging

As the preceding survey has shown, a lot of information that may be used to reconstruct the KVs' social insurance operations in a quite informative way and to generalize on issues related to the welfare state is provided. Now I make use of part of the data on Prussian KVs to provide some historical evidence on a hitherto much debated question in the economics: How does population aging affect the finances of pay-as-you-go financed old-age programs? The least that an economic historian, as I am one, can contribute to answer this question is to "point a spotlight" at our past experience and to trace if people, say, in the late nineteenth century, already saw themselves confronted with problems of which one may think that they are something very special to today's advanced, matured welfare states. Provided people already felt so a hundred or more years ago, how did they cope with the challenges that they perceived were emerging?

The KVs, and the contemporary observers discussing their affairs, already saw themselves confronted with a challenge very similar, in the end, to one modern pay-as-you-go social insurance has been dealing with: increasingly more old, retired people have become economically dependent on the transfers financed by a relatively shrinking working population – a population, though, that might have produced with constantly rising productivity.

Yet, at first glance, there is a big difference between the way KVs operated and the way modern old-age programs do: KVs did not explicitly insure old-age. Theirs was to insurance against invalidity, which could have occurred at *any* a miner's age, but for which a KV nonetheless paid until the invalid's death (and beyond, as the existence of survivors' benefits show). In fact, the mental concept of a retirement phase naturally following working life after passing the age of 60 or 65 had not yet made its way in the nineteenth and early twentieth century (Conrad 1994, 12; Göckenjan and Hansen 1993, 731). Actually, to bring in KVs as a "historical laboratory" requires emphasizing the social dimension of population aging over the pure biological dimension.[15] The old-age dependency ratio, a measure often applied in aging-related investigations, reflects this dual view pretty well. For, on the one hand, it relates the number of people below an assumed threshold age of 60 or 65 to people above that age and, on the other hand, it relates the number of working people to the number of retired people, thereby implicitly highlighting the redistributive relationship between both parties.

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[15] The distinction into "biological" and "social" ageing has been advocated by, for example, Bourdieu and Kesztenbaum (2007), 185.

Fortunately, we can construct four simple measures from the KV statistics that are quite similar to the old-age dependency ratio, namely the invalids-to-contributors ratio (ICR), the survivors-to-contributors ratio (SCR), and both ratios' respective reciprocals, the invalids-support ratio (ISR) and the survivors-support ratio (SSR).

Let us begin with the former two ratios. Table 4 reports both measures as median values over the *N* KVs that were operating over the respective periods. I split the universe of Prussian KVs into two samples, namely "stagnant" and "dynamic" ones. A KV was ascribed to the former sample if it showed a stagnating, or shrinking, contributor base over the period 1861-1920 (i.e., an average geometric growth rate of working membership < 0); it was ascribed to the latter if its contributor base grew positively in the long-term (i.e., by an average geometric growth rate > 0). The reason as to why this distinction makes sense is the following: Due to the fact that a KV was either responsible for miners of a particular mining company or, instead, for a particular insurance area (quite similar to territorial monopolies), expansion of the working, and contributing, membership was limited by the growth opportunities that the particular mining company, or the companies in the KV's area, faced. If mining had thrived and local resource deposits had still been rich, labor input would have been increased, and so would have had a KV's working membership; in contrast, if mining had stagnated, because local resource deposits were nearly exhausted (either technically or economically), labor input would have stagnated, and so would have had a KV's working membership. So, while stagnation of mining activities would have certainly resulted in increasing economic dependency of ever more pensioners on ever fewer contributors, KVs in prospering areas, and with expanding working memberships, might not have felt rising pressure on finances at all. We have to control for this effect.

Yet, as we can infer from Table 4, not only did stagnant KVs experience a rising ICR and a rising SCR, but also did dynamic ones, though not to the same extent. For example, stagnant KVs' median burden with invalidity pensioners in the period 1861/1865 was 0.02 invalids per contributor (or, when multiplied with one hundred, two invalids per 100 contributors). As of around 1913, the median burden had increased to 0.19 invalids per contributor (or 19 per 100). Dynamic KVs obviously faced a slower rising burden with pensioners, but long-term expansion of working membership was, in itself, no guarantee for not experiencing aging. As the standard deviation shows, there was a considerable range of burdens with pensioners to be observed. One might wonder how, say, the median burden displayed in Table 4 compares to that of systems of the second half of the twentieth century. For German pension insurance, for example, we can calculate that there were 39 pensioners per 100 contributors in 1993 and 46 in 2006 (Deutsche Rentenversicherung Bund 2008, 14, 169). So, summing over the ICR and SCR, stagnant KVs partly exceeded those levels, and dynamic KVs were, at least, on the way to arrive at such levels.
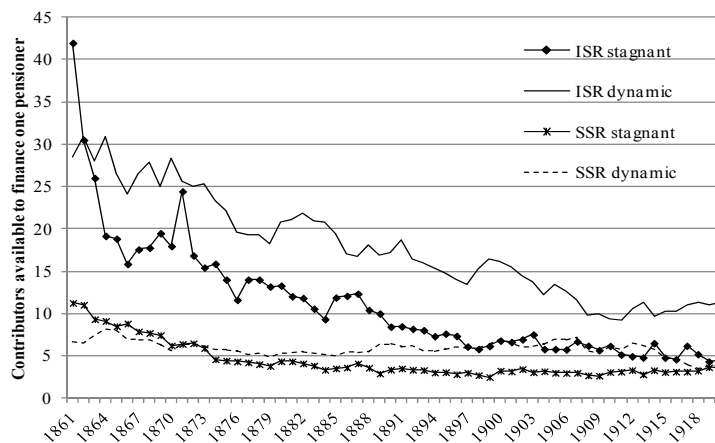
Table 4: Rising Economic Dependency in the *Knappschaften*

Period	Stagnant Knappschaften					Dynamic Knappschaften				
	N	ICR		SCR		N	ICR		SCR	
1861/1865	28	0.02	(0.07)	0.08	(0.15)	49	0.03	(0.04)	0.12	(0.14)
1866/1870	36	0.03	(0.13)	0.13	(0.19)	57	0.03	(0.06)	0.15	(0.13)
1871/1875	34	0.04	(0.22)	0.17	(0.31)	61	0.04	(0.03)	0.16	(0.12)
1876/1880	29	0.07	(0.29)	0.23	(0.44)	56	0.05	(0.04)	0.19	(0.12)
1881/1885	28	0.08	(0.20)	0.25	(0.49)	55	0.05	(0.04)	0.19	(0.11)
1886/1890	26	0.08	(0.18)	0.28	(0.26)	51	0.06	(0.04)	0.17	(0.11)
1891/1895	25	0.12	(0.14)	0.30	(0.27)	48	0.06	(0.08)	0.17	(0.16)
1896/1900	25	0.16	(0.14)	0.35	(0.33)	48	0.07	(0.08)	0.16	(0.15)
1901/1905	25	0.14	(0.13)	0.32	(0.50)	48	0.07	(0.06)	0.16	(0.08)
1906/1910	25	0.15	(0.20)	0.35	(0.80)	47	0.09	(0.05)	0.17	(0.09)
1911/1915	22	0.19	(0.12)	0.32	(0.25)	44	0.10	(0.09)	0.18	(0.14)
1916/1920	17	0.19	(0.14)	0.29	(0.22)	39	0.09	(0.06)	0.25	(0.11)

Notes: Displayed per period are the rounded median of average scores and the standard deviation (in brackets); see text for abbreviations.
Sources: See text.

Figure 1: The "Inverse" Picture – Pensioner Support Ratios

Notes: Displayed per year is the respective median ratio; see text for abbreviations.
Sources: See text.

We can put the process of rising economic dependency among the KVs in a yet even more illustrative way by asking the question the other way around: How many working miners were there, on average, to finance one retired miner? To answer this question we require information on the support ratio, which is simply equal to the inverse of the ICR (or SCR). Graph 1 plots these inverse ratios, the median ISR and SSR. What we find is that the number of contributors ready to support one invalid, or one survivor, notably decreased at the

median – regarding stagnant (dynamic) KVs, from 42 (28) contributors per one invalid in 1861 to less than five (12) in 1920 and from about 12 (7) contributors per one survivor to less than five (four).

Now one might ask as to whether increases in the ICR/SCR, or decreases in the ISR/SSR, might have been compensated by increases in productivity and, thus, wages. In other words, would it generally constitute a serious problem at all seeing ever less contributors relative to pensioners? This seems to depend on whether pensions already granted were adjusted to growth, too. If so, as in Germany nowadays, we might doubt that steadily rising productivity is sufficient to solve the problem. However, nineteenth- and early twentieth-century KVs, as well as Bismarckian pension insurance, did not know (automatic) adjustments of pensions to (i) economic growth (of the mining sector or, respectively, of the whole economy) or (ii) price developments *after* pensions had factually become due. To answer this question in our particular case of static pensions, a simple exercise will do: We only need to compare the long-term growth of wages with the long-term growth rate of the ICR/SCR.[16] Wages on mining (including salines) can be obtained from Hoffmann (1965, 461). Covering the years 1861 to 1913, his series yields a long-term growth rate of 2.04 percent (1.67 percent over 1867-1913). In contrast, the median ICR among stagnant (dynamic) KVs rose by 6.9 (2.3) percent in the long-term; the median SCR among stagnant (dynamic) KVs rose by 3.66 (0.32) percent. In fact, economic dependency increased faster than wages did.[17]

To end this subsection, I provide additional evidence on the biological dimension of the KVs' aging memberships. Therefore I bring in three further measures, namely the "average age of invalids", the "average invalidity pension duration", and the "average age at retirement". Table 5 contains the corresponding information. I concentrate on invalidity pensioners here since there were much more costly than survivors, although their number was usually lower.

For each KV the average age of invalids has been calculated as the weighted average over age-groups (i.e., variables subsumed under item MSQ 4.6) assuming that all invalids in an age-group were exactly of mid-group age. Evidence suggests that the median average age increased in the long-term for both stagnant and dynamic KVs – from 59 to 65 in the former case and from 57 to 59 in the latter – indirectly pointing to a rise in life expectancy.

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[16] That KVs granted miners Otto and Wilhelm static pensions, which nominally remained unadjusted over their retirement period, should not be confused with their ability to raise Friedrich's pension before it actually became due.

[17] Throughout this article, the empirical extent of economic dependency among KVs has to be understood as net of countermeasures that would increase the contributor base relative to the amount of pensioners, e.g., sharpening eligibility rules over time, which would have reduced the share of accepted invalids in total applicants. Unfortunately, we cannot measure this effect on the basis of the statistics.

Table 5: Measuring the "Biological Side" of Aging

Period	Stagnant *Knappschaften*			Dynamic *Knappschaften*		
	Average age of invalids	Average invalidity pension duration	Average age at retirement	Average age of invalids	Average invalidity pension duration	Average age at retirement
1867/1870	59 (9)	–	53 (8)	57 (7)	–	51 (8)
1871/1875	59 (6)	–	56 (7)	56 (6)	–	52 (8)
1876/1880	58 (6)	–	53 (8)	56 (5)	–	51 (7)
1881/1885	59 (6)	–	54 (8)	56 (6)	–	52 (7)
1886/1890	60 (6)	–	54 (7)	57 (5)	–	52 (8)
1891/1895	61 (6)	–	55 (8)	58 (5)	–	53 (7)
1896/1900	63 (5)	–	55 (3)	58 (5)	–	53 (7)
1901/1905	63 (5)	7.5 (4.9)	54 (8)	58 (4)	8.0 (4.9)	53 (7)
1906/1910	62 (5)	9.0 (6.1)	55 (7)	59 (4)	8.5 (3.5)	54 (6)
1911/1915	63 (4)	10.0 (6.3)	56 (8)	59 (4)	9.3 (3.8)	54 (6)
1916/1920	65 (4)	12.4 (5.0)	56 (7)	59 (4)	9.9 (4.0)	54 (6)

Notes: Displayed per period is the rounded median of average scores and the standard deviation (in brackets).
Sources: See text.

The second measure is directly obtainable from the KV statistics (MSQ 4.15) and informs us about for how many years an invalid who died over the course of year *t* had received his invalidity pension. Unfortunately, we only have the necessary data from 1900 onwards. For stagnant KVs, as for dynamic ones, the median average pension duration rose over the twenty years we can observe, by nearly five years and, respectively, two years. But do these increases really reflect rising life expectancy or do they simply reflect a decreasing effective retirement age? In order to answer this question we have to take a look at measure three, which is the median average age at retirement among all stagnant and, respectively, dynamic KVs. That the average pension duration became longer and longer could have appeared simply because miners became invalid earlier than before, for example, due to adverse incentives to retire earlier or due to the production environment. But, rather, data show that the average age at retirement increased over 1900-1920, which is a clear hint at rising life expectancy. There are two main explanations for this trend. First, technological progress made mining less perilous and lethally such that many miners who would once have died before they could be retired, actually came to see retirement; and, second, medical-technological progress, in particular, making treatment of those involved in accidents and of those suffering from diseases like the black lung more effective such that death was postponed.

3.2 Contribution Rates and Generosity under Pressure

Recall that, faster in the period under observation, economic dependency grew than wages. Yet, one might ask as to whether KVs were able to compensate for

growth of wages lagging behind by cutting the amount of benefits receivable before they actually were granted. This question directly touches on the question of how the KVs reacted to increasing financial pressure. I will assess this question by making use of one crucial identity: In a pay-as-you-go pension system the contribution rate (*CR*) is equal to the product of the pensioners-to-contributors ratio and the pension level; the latter is the ratio of the average pension to the average wage in the population of insurants and, thus, determines the system's average income replacement standard. Having estimates of the ICR and SCR at hand, as well as of the replacement rate, the contribution rate follows as a residual. According to Disney (2004, 274), we might call this contribution rate more accurately the "equilibrium contribution rate", because miscellaneous costs, miscellaneous revenues, and reserves are assumed to be zero. In comparison, we could estimate the contribution rate by referencing the observable amount of contributions paid per capita against wage, regardless of having estimates of the ICR, SCR and replacement rates at hand or not. The following exercise is built around the concept of equilibrium contribution rates.

Let us begin with the KVs' generosity. For the moment, is it sufficient to have a look at how generous KVs were at the start of their existence as insurers, thus in the cross-section of 1861. To obtain KV-level estimates of pension levels regarding invalidity, widows' and orphans' pensions, we need to divide the average pension (e.g., E1.2 / MSQ 4.1 and, respectively, E1.2 / MSQ 4.2), year by year, by the average wage in the mining sector.[18] I again use Hoffmann's series on wages in the mining sector as well as his series on wages in metal production for those KVs that mainly insured metalworkers. Table 6 depicts generosity assessed this way. Obviously, KVs that would experience stagnation later on were much more generous, at the median, regarding provision for invalidity than were those that would prosper in the long-term. Possibly, stagnant KVs were simply too optimistic about their business prospects. A pension level, or replacement rate, of 28.5 percent was definitely not a bad deal for the time. Survivors' pensions were naturally lower.

Table 6: Generosity in the Cross-Section of 1861

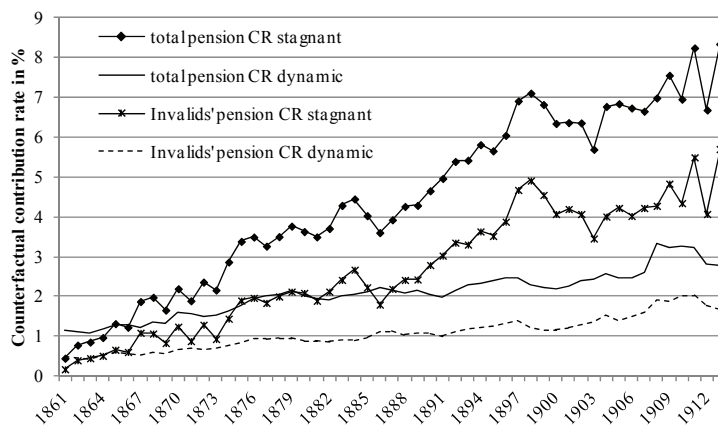| Median pension level stagnant KVs			Median pension level dynamic KVs		
(N = 26)			*(N = 45)*		
Invalids' pensions	Widows' pensions	Orphans' pensions	Invalids' pensions	Widows' pensions	Orphans' pensions
28.5 %	9.0 %	4.1 %	18.7 %	9.4 %	3.2 %
(11.7)	(5.2)	(2.8)	(10.7)	(5.8)	(1.5)

Notes: Standard deviation in brackets.
Sources: See text.

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[18] According to Sprenger (1991, 187), one thaler (1861-1874) has been converted into three marks.

Against the background of the basic identity mentioned above, the KVs could principally pursue three different strategies to adjust their finances. The first is not assessable with the available data, namely to either tighten eligibility criteria ruling whom invalidity status would be granted or soften eligibility criteria ruling which contributor would enter established membership and pay a contribution that would be higher than that among unestablished miners.[19] The second and third ways, namely to adjust contributions upwards or generosity downwards, are indeed assessable. It seems reasonable to build a straightforward counterfactual scenario by asking how strongly the contribution rate, say, for the KV pressed with aging according to the median economic dependency scenario displayed in Table 4, would have had to rise if the pension level was to be hold constant over 1861-1913 at the 1861-levels.[20]

Graph 2: Counterfactual Equilibrium Pension Contribution Rates in the "Median Burden" Scenario

Notes: Pension levels hold constant at the level of 1861.
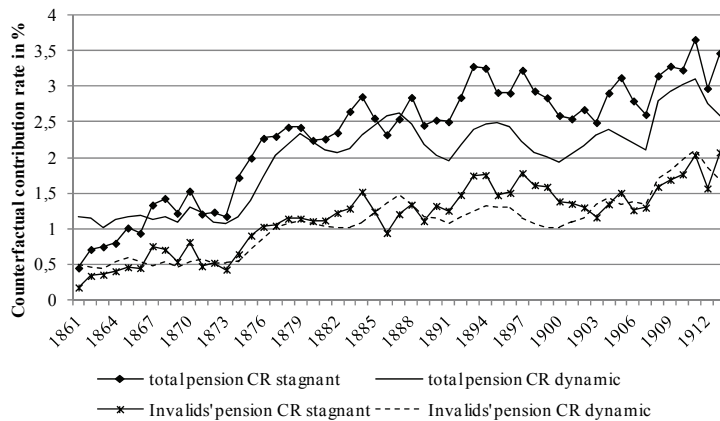*Sources*: See text.

Graph 2 visualizes how the median equilibrium contribution rates would have had to rise for stagnant and dynamic KVs to be able to provide an invalidity pension level of 28.5 and, respectively, 18.7 percent over the whole period. Stagnant KVs had started with an equilibrium contribution rate less than 0.18 percent, and dynamic ones with 0.5 percent. Whatever the starting conditions, KVs would have seen a contribution rate of around six and 1.8 percent in 1913,

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[19] Of course, softening criteria for achieving established status now meant to have to provide for more costly pensioners later.
[20] I restrict the following exercise to the years 1861-1913, because there is a gap in Hoffmann's series until 1923.

respectively, had they maintained equilibrium while holding generosity with regard to invalidity constant. The counterfactual "total pension contribution rate" accounting for survivors' pensions, too, would have grown even faster, up to around eight and three percent, respectively. [21] The fact that a KV might have been on a positive growth trajectory definitely dampened the financial consequences of rising economic dependency.

Graph 3: Actual Equilibrium Pension Contribution Rates in the "Median Burden" Scenario

Notes: Pension levels no longer kept constant.
Sources: See text.

The counterfactual as a first step is necessary in order to judge the time path of the *actual* equilibrium contribution rate adequately. Now the restriction of constant 1861 pension levels will be lifted. Graph 3 depicts actual equilibrium contribution rates inclusive of historical adjustments made via the generosity channel. As was to be expected, contribution rates did rise as a rule, but not as fast as they did in the counterfactual scenario. The difference between counter-factual contribution rates on the one hand and actual contribution rates on the other reflects the extent to which the welfare level was reduced in order to take financial pressure off workers.

What is still to do is to quantify the level of generosity at which the KVs arrived. Blinding out the extraordinary years of war and undisguised inflation, Table 7 shows that the median invalidity pension level among stagnant KVs eventually declined by approximately two-thirds, to just less than 11 percent; the pension level with regard to survivors was similarly adjusted downwards.

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[21] Note that these contribution rates *do not* account for non-pension cost.

Table 7: Generosity at the Onset of War (1911/13)

Median pension level stagnant KVs			Median pension level dynamic KVs		
(N = 22)			(N = 44)		
Invalids' pensions	Widows' pensions	Orphans' pensions	Invalids' pensions	Widows' pensions	Orphans' pensions
10.6 %	5.3 %	1.8 %	17.7 %	9.1 %	2.8 %
(6.7)	(2.6)	(0.8)	(9.3)	(6.6)	(1.6)

Notes: Standard deviation in brackets.
Sources: See text.

At first glance, it might look quite positive that dynamic KVs, due to the economic environment they were embedded in, seemingly managed to sustain the generosity levels at which they once had started. In reality, though, dynamic KVs were not really better off. Figuratively spoken, they all had, at some point in time, to backpedal quite considerably to a level of generosity that they perceived to be sustainable. Note that, as of the late 1880s, they already had arrived at median pension levels of about 25 percent, 11 percent, and 3.5 percent, respectively. This observation suggests that the advantage of steadily growing KVs over steadily shrinking funds in mastering the "aging challenge" was not that big after all.

4. Concluding Remarks

The KVs formed a small part of the many mutual relief societies operating in Germany in the nineteenth and early twentieth century. Miners, who had access through their KVs to a comprehensive package of different kinds of benefits addressing quite different risks, seem to have been privileged compared to other industrial workers. They relied upon their own insurance system that would later co-exist with *Reich* insurance. What is more, the KVs are statistically quite well documented enabling us to reconstruct much of their historical experience and, thereby, to shed light on aging as a major challenge of the modern (Bismarckian-style) welfare state.

Usually, rising life expectancy and aging are analytically assessed for an economy's entire population, thus on the macro-level. Yet, there is also a micro-level on which these issues may be assessed; the KVs provide such a micro-level perspective. Their historical experience illuminates the fundamental tension in a maturing pay-as-you-go pension system between allowing retired members to benefit from a preferably high welfare level and burdening financiers at the same time with a still acceptable load of contributions. Against the background of this trade-off between the degree of generosity and the degree of revenue extraction, KVs sooner or later decided to cut generosity, which took off some pressure of the contribution rates, but which adversely affected insurants' welfare position. Alone that the KVs had the possibility to make quite

strong use of lowering the pension levels, draws our attention to the still different situation today. Look at Germany, for example, where the (average) income replacement standard of old-age insurance still remains untouched. However, since the standard is based on political decisions, there is no true guarantee that it will remain untouched in the future. The empirical exercise is not meant to make a normative statement on whether maintaining a high average pension level is still acceptable or not. Rather it is intended to document the trade-off's importance then and now.

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