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Insurance, Big Data and Changing Conceptions of Fairness

Abstract

This paper aims to show how insurance mechanisms that historically propelled a conception of fairness based on solidarity and a collective approach shifted along the 20th century towards an idealistic adjustment to individual risk. Insurance originally assumed that, while individual hazards remained unknown, risk could be measured and managed on the aggregate. An examination of the proceedings of the American Casualty Actuarial Society (CAS) during the 20th century demonstrates the slow crystallization of another conception of fairness, that aims at a scientific adjustment of insurance premiums to actual "individual risks." I argue that this conception of fairness deconstructs the one based on solidarity. Big data technologies have further radicalized this shift. By aiming at predictive individual risk scores rather than average costs estimated on the aggregate, the algorithms contribute to replacing fairness as solidarity by the correctness of a computation.

Keywords: Insurance Fairness; Solidarity; Risk Individualization; Classification; Big Data.

Introduction

IN HIS HISTORICAL DESCRIPTION of the last two centuries of data analysis, Bouk [2017] distinguishes between three periods. In the first, which lasted roughly until the beginning of the 20th century, modern bureaucracies grasped people through their "data doubles," used to classify individuals along broad categories such as race, gender, class and region. During the first half of the 20th century, attempts were made to refine the classification so as to create "statistical individuals." A final step was achieved in the 1970s, "amid economic crisis, technological change, and liberatory politics," with the creation of *individual* scores.

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While one might question, as I do below, that statistical individuation was possible prior to the advent of big data, there is no doubt that individual scores are now the main tool deployed for the understanding of social phenomena. Algorithmic personalization has indeed become a pervasive trend in almost all domains of our lives [Lury and Day 2019].

The shift has sweeping consequences. As Lury and Day [2019: 18] rightly remark, personalization has implications on "how we live together, that is, on forms of sociality." There is indeed a "political economy" behind personal data [Bouk 2017: 86]. Bouk, for instance, contends that the creation of large aggregates in the 19th century helped construct social imaginaries such as nations [Bouk 2017: 89; see also Hacking 1982]. Beyond imaginaries, the study of the neoliberal credit market in the United States allowed Fourcade and Healy [2013] to further show how the process of assessing credit worthiness created "classification situations," with discriminatory impact on specific populations. I would rather question here the social implications of personalization, once it has become the new imaginary of the collective, with a specific focus on fairness and insurance.

The focus on insurance and/or fairness might come as a surprise. Yet long before insurance became a common practice, the first probabilists were busy determining the fair price of aleatory contracts, demonstrating the lifelong entanglement of insurance with issues of both fairness and knowledge [Daston 1987]. In addition, insurance is deeply embedded in our daily lives, both reflecting and imposing a changing political rationality and a social imaginary [Ewald 1991: 198]. It entails a form of governance, and it dictates practices and a cultural framework for concepts and values such as "time, destiny, providence, responsibility, justice" [Ericson, Doyle and Barry 2003: 6]. The study of changing insurance practices resonates, therefore, with the larger issues of social imaginaries and the way in which they shape our daily practices. Bouk, Fourcade and Healy all note that current techniques of data treatment and classification are *actuarial* techniques. Engaging with actuarial literature should therefore allow us to better understand how classes are constructed or deconstructed, and what kinds of social imaginaries emerge from the process. Some have proposed that social imaginaries and cultural representations impact the functioning of the economic sphere. Beckert, for instance, suggests that fictional expectations feed the decision making of various actors under uncertainty [Beckert 2013: 236; 2016: 12]. It is also sometimes claimed that culture influences insurance and market practices [Zelizer 1979; see also Baker and Simon 2002: 15]. One might wonder in return how economic practices, and

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specifically here insurance techniques, impact the imaginary of the social.

Ericson, Doyle and Barry [2003] thus distinguish between two conceptions of insurance fairness, that derive from the risk pooling technique. On the one hand, techniques of welfare create "large and undifferentiated pools," where the level of solidarity between different kinds of risk is strong. On the other hand, private industry identifies homogeneous segments so as to "minimize welfare social transfers," proposing the fair adjustment of premiums to risk as an alternative [Ericson, Doyle and Barry 2003: 5; see also Lehtonen and Liukko 2011]. From a historical perspective, the crisis of the welfare state and the rise of neoliberal policies have implied a shift of insurance from the state as a main provider towards private insurance [Rosanvallon 1995; Baker and Simon 2002; Ericson and Doyle 2004; Armstrong 2005]. This shift puts stronger focus on fairness as the adjustment to risk propelled by private insurance, which continues to function as a "social technology of justice" [EricsonDoyle and Barry 2003: 7].

I would like in what follows to question the clear demarcation between these two forms of insurance fairness. While they appear today as distinct practices that derive from rival ideologies and actors (welfare vs. neoliberalism; public vs. private insurance), I aim to show here that the adjustment to individual risk, equated today with actuarial fairness, was for long known to be an unattainable and unclear ideal. While it is true that insurance has traditionally incorporated personal information in its prices [Moor and Lury 2018] and its selection of insureds [Bouk 2015], the viewpoint remained aggregative: indeed statistical knowledge consisted in the *creation* of a collective standpoint, at odds with the idea of an individual risk. For a time, the calculation of means on large portfolios organized in classes was in fact the state of the art of actuarial science, and this was considered as a legitimate and fair practice.

The actuary has thus not always strived for the adjustment of premiums to individual risks; he simply lacked the tools for such an endeavor. Actuarial practice was in fact bound by a double constraint: first, the constraint imposed by technology led to solidarity; second, and in tension with the first, the constraint imposed by competition. Segmentation was indeed driven by the need to secure a situation in which premiums would meet losses overall, with no one else "skimming the cream" by attracting the best segments.[1] The current practice of actuarial

[1] The expression comes from some actuaries.

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fairness, defined since the 1980s as the adjustment to the *individual's* risk, derives in fact from technical tools, data, and knowledge that slowly crystallized during the 20th century. The sophistication deployed to create increasingly more refined segmentation has been further magnified by recent big data technologies aimed at personalization. In the context of insurance and beyond, I would like to argue, the aggregation into categories served an imaginary of solidary groups. In contrast, the complexities of today's algorithms [Pasquale 2015] and the faith in their ability to bypass human categorization [Bamman, Eisenstein and Schnoebelen 2014; LeCun, Bengio and Hinton 2015] delivered a final blow to the possibility of imagining the group which supports the pooling [Barry and Fisher 2019], therefore deconstructing the concept of solidarity. The current conception of actuarial fairness as the individualization of risk thus resolves the tension that existed with fairness as solidarity: competition, the law of the market, knowledge and fairness all sit today on the same side.

Interestingly enough, in their critical reflection on classification, Fourcade and Healy recognize, besides market economy, the historical force of the technology that pushed it: "namely, the growing availability of individual level data, on the one hand, and the development of statistical models of risk on the other" [Fourcade and Healy 2013: 562]. In the case of insurance, the neoliberal turn and the growing technical capacities serve as a strong background to a series of class actions in the 1970s that questioned the fairness of classification and forced actuaries to define "standards of classification:" while these standards seem at first sight to defend classification as a group approach, they also define actuarial fairness as the absence of subsidies *within* the class (thus in fact accepting some of the claims against classification). This paved the way, I will argue, for the current concept of adjustment to *individual* risk.

This paper thus aims to show how technology accompanied and fed the shift from one conception of fairness to another, deeply at odds with the first. It is based on a reading of the proceedings of the American society of non-life actuaries, the Casualty Actuarial Society (CAS). The first part exposes the reasons for this choice and describes the relevant corpus. The second part briefly describes how insurance mechanisms took shape with the construction of a novel point of view on human phenomena: one that considers the population as an object of knowledge. It proceeds to show how this perspective was the one adopted by the first actuaries of the CAS. The third part follows the debates around automobile insurance segmentation and the growing challenges to the initial conception of fairness: pushed by competition, actuaries are indeed

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introducing more segmentation into the classification, with the need to explain the fairness of this practice. The last part describes the definition of actuarial fairness crystalized in the 1980s as the adjustment to individual risk, and discusses the implications of the recent technological shift on this concept brought about by big data and new algorithms.

Corpus: the proceedings of the casualty actuarial society

The proceedings of the Casualty Actuarial Society (CAS) provide a good indication of how segmentation was slowly introduced to non-life insurance in the United States. Officially, the society was created in 1914 to organize and orient non-life actuaries in their assessment of the newly mandatory workers' compensation insurance. It followed the 1889 creation of the Actuarial Society of America, that federated life actuaries (originally approximately 100 persons—see Society of Actuaries n.d.). But the life organization did not reflect the preoccupations and existing practices of the growing non-life (essentially liability at the time) business; at the inaugural meeting of the CAS, that gathered another 97 men [Bryan 2014: 15], Stanley Otis, the actuary of the Bureau of Liability Insurance Statistics read a letter motivating the creation of a new scientific society:

> *Neither the American Mathematical Society, the Actuarial Society of America nor the American Statistical Association, in their Bulletins or Transactions, covers a field beneficial to the mathematical men of the Liability Companies. What is needed is a society of our own dealing with subjects of direct interest to us*. The questions of uniformity of keeping companies' statistics, method of compiling statistics on which to base Workmen's Compensation rates, methods of computing liability loss reserves and other equally pertinent subjects are of prime importance and could be studied by *the collective body of actuaries and statisticians with great profit* [CAS Proceedings 1914, vol. 1: 8-9, emphasis added].

The collective body was thus supposed to answer questions linked to an amorphous domain using mathematics, actuarial science and statistics (for its first five years, it was called the Casualty Actuarial *and Statistical* Society). It was therefore firstly thought of as an academic body seeking professional education, long before the different actuarial societies federated into the American Academy of Actuaries (AAA) in 1965.[2] In his inaugural address, Isaac Rubinow, the CAS's first president

[2] The AAA was created in order to provide accreditation "that would be recognized *across specialties by state and federal officials*" [American Academy of Actuaries 2015, 13, emphasis added], with the need to gain authority vis-àvis certified accountants for

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(a statistician), states that he believes that "such a society will soon take its position among the *academic societies* of our country" [CAS Proceedings 1914, vol. 1: 2, emphasis added]. This educational focus was confirmed in Article II of the Constitution that was adopted six months later:

> Article II. Object. The object of the Society shall be *the promotion of actuarial and statistical science* as applied to the problems of *casualty and social insurance* by means of personal intercourse, the presentation and discussion of appropriate papers, the collection of a library and such other means as may be found desirable. *The Society shall take no partisan attitude*, by resolution or otherwise, upon any question relating to casualty or social insurance [CAS Proceedings 1914, vol. 1 (2): iv, emphasis added].

While the society presents itself as seeking neutral and objective knowledge devoid of ideological bias, tensions can sometimes be felt in between the lines. Some were purely personal, such as the removal of the term statistics from the title of the society, a few years after the 1918 presidential address of its second president, James Craig (an actuary), differentiating the actuary from the statistician [Kilbourne 2014]: while they use similar techniques, the statistician provides a description of phenomena in a variety of domains, whereas the actuary is focused on insurance, combining statistics with interest for the estimation of future events [CAS Proceedings 1918, vol. 5: 1-9].

Other tensions were political, dealing with the interpretation of the "social insurance" mentioned in Article II of the Constitution [Kilbourne 2014: 30-31]. While it would probably have enlightened our understanding of what triggered the changes in conceptions of fairness, tracing the political position of each speaker was not possible for a number of reasons. First, besides the presidential addresses, most of the articles express scientific opinions and are presented to the association as such. Looking backward at the actuaries at their beginning, the first president of the newly formed Academy reflected that they were for long "a private, inward-looking, narrowly focused *group of experts*" [American Academy of Actuaries 2015, 9, emphasis added]. They often defined themselves more modestly as *technical men* [e.g. CAS Proceedings 1921, vol. 8: 185; 1926, vol. 12: 211). Second, very little is known about them

the sign-off on reserves. The American Academy of Actuaries therefore emerged from what Abbott coined as a conflict over jusrisdiction with the accountants: "As custodian of professional knowledge in its most abstract form, this *academic* centre is uniquely situated to claim new jurisdictions. But the claims are cognitive only. They cannot become recognized jurisdictions without concrete social claims and legitimating responses. Inter-professional competition, that is, takes place before public audiences" [Abbott 1988: 58]. In Sciulli's terms, actuarialism thus turned into a profession, with the necessary public recognition, only after the creation of the Academy [Sciulli 2007: 121].

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from the proceedings, not even their affiliation at the time of presenting their papers. Some elements were gathered from testimonies provided by the actors themselves on specific occasions (the first 50 years, or the centennial). Nor did an examination of the relevant obituaries reveal any outstanding political activity: some were academics in parallel or in alternance with their work in insurance companies, comforting the view of a community of experts.

I propose in what follows to look at the proceedings with this lens of an "inward looking" expertise in the making. The community of actuaries and their technical tools in a given time and place appear here as a "collective calculative device," implying both humans and machines, and interactions between the two. The debates among actuaries thus show, in my view, how the "collective hybrid" formed by the actuaries and the computers negotiates and re-negotiates the calculation of risks over time [Callon and Muniesa 2003].

Starting in 1914, the bi-annual meetings gathered the members of the society, and selected papers were presented to the assembly before being published in the proceedings. At times, foreign actuaries came to share their own scientific insights on specific issues. These proceedings are fascinating documents for the understanding of the shift in conceptions of actuarial fairness, for a number of reasons. First, as members of an American actuarial society, the actuaries were confronted with the need to give meaning to the somewhat contradictory principle posed by the Commissioner in 1909 that rates should not be "unfairly discriminatory" [Miller 2009]. The proceedings show how the interpretation of this principle was renegotiated over time, thus renewing the definition of actuarial fairness. Second, since casualty insurance was relatively new as compared to life insurance,[3] the techniques and practices were not yet established at the time of the creation of the society. It is therefore possible to follow in the proceedings the crafting of a new actuarial knowledge, one guided by the interpretation of the principle of fairness imposed by the Commissioner. A possible reading of the proceedings, proposed below, consists in the slow crystallization of professional standards for "adequate and fair" pricing. Articles were therefore singled out for their specific reference to fairness. Very quickly in the proceedings, the issue became associated with classification in automobile insurance, where segmentation is discussed both in terms of competition and fairness.

[3] See CAS Proceeding vol. 1: 8-9; the liability business developed around 1890.

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Finally, dealing mainly with annual policies, property and casualty insurance is by nature more dynamic and prone to changes in its pricing than life insurance. In his history of the mortality tables, for instance, Hustead [1988: 13] notes that the "American experience table" was the primary statutory table in life insurance from 1868 until 1941 [see also Moir and Elston 1919: 36]. While other tables were used in pricing, the statutory reference to the same table for more than 70 years is telling.[4] Following the debates around motor rate segmentation is therefore particularly enlightening. However, the conclusions on changing conceptions of fairness drawn from the study of the automobile sector remain valid for other branches of insurance. The current calculation of individual risk scores in health, for instance, also serves the redefinition of solidarity [McFall 2019].

Fairness as solidarity: creating homogeneity

Prior to the big data era at least, statistics relied on a quantification process. To quantify, says Desrosières, is "to express and to make exist in a numerical form what previously was expressed by words and not by numbers" [Desrosières 2008: 10]. It therefore implies a transformation, performed by the expert in charge of the analysis. It consists in choosing the questions to be asked, and in a priori categorizing the possible answers. This quantification, I argue, *created* a homogeneity that allowed the exhibition of a regularity of the collective phenomena. The homogeneity is thus produced twice: once in the choice of what is *not* asked and therefore ignored, and once in what is asked and categorized. The categories indeed create "classes of equivalence," that erase any distinction between the members of the class. For Desrosières, the choice of questions and answers is always arbitrary and projects onto the object of analysis a predetermined vision of the phenomenon to be studied [Desrosières 2008: 135].

For Porter, quantification thus creates standardization that "averages away" the noise of individuals:

[4] This is not to say that no actuarial studies on various segments were made during the period [Bouk 2015; see also Moir and Elston 1919]. Yet most of the rate adjustment beyond basic demographic parameters (age, gender, smoker status) is, to this day, left in the hands of the underwriters who perform individual case studies [Batty *et al.* 2010]; in Bouk's terminology, underwriters (like doctors) are classing, whereas actuaries are smoothing [Bouk 2015, xiii-xiv]. As will be shown below, the CAS actuaries were, from the 1920s onwards, busy refining the segmentation and the *rating* plan, or the smoothing part.

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> Inevitably, meanings are lost. Quantification is a powerful agency of standardization because it imposes order on hazy thinking, but this depends on the license it provides *to ignore or reconfigure much of what is difficult or obscure*. As nineteenth-century statisticians liked to boast, their science *averaged away everything contingent, accidental, inexplicable, or personal*, and left only large-scale regularities [Porter (1995) 1996: 85, emphasis added].

Insurance mechanisms took shape in this context: the combination of statistics with probability created new tools for the management of hazards, with a focus *on the aggregate*. It propelled a notion of solidarity, expressed by Léon Bourgeois concerning workers' compensation schemes as follows: "the only means that we have to solve the difficulty is *to pool the risks and the advantages*, which means to accept in advance that *without knowing who will bear the risk and who will benefit from the advantage*, risks will be borne collectively and access to social advantages will be open to all" [Bourgeois *in* Ewald 1986: 370, emphasis added, personal translation].

The pooling, at the heart of the insurance technique, meant the abandonment of the individual level and the conceptualization of risk along large classes of individuals taken as exposed to the same risk. It therefore creates a solidarity, understood as the "community of fate" [Hollinger 2006] of the members of the class collectively facing the same hazards. It is built on the double claim that *individual risks cannot be known* (they are seen as errors) and that they can be more or less precisely measured, and therefore managed, collectively on the group. For Lehtonen and Liukko, this insurance solidarity is distinct from Durkheim's organic solidarity as it is "the intentionally planned relationship between humans" that derives from the specific rationality of insurance [Lehtonen and Liukko 2015: 159-160]. It thus replaces an equality as identity by an equality of exposure to uncertainty and accidents. Slowly, however, with the refinement of technological tools and the collection of data, segmentation was introduced that adjusted the rates to *subgroups* in the population, yet always within the same aggregate logic.

The first debates of the CAS deal with the newly created workers' compensation insurance. Contrary to some European countries, the workers' compensation act was to be managed in most states of the United States through private insurance. However, rates were to be filed and approved by insurance commissioners, and should prove to be "fair, adequate and reasonable," or "not unfairly discriminatory."[5] The

[5] "According to a decision of the United States Supreme Court (German Alliance vs. Lewis 233 U. S. 389) the insurance companies generally are conducting a business *which is strongly impressed with a public interest* and therefore they are subject to the closest kind of supervision and regulation" [CAS Proceedings 1921, vol. 8: 179, emphasis added].

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interpretation of the latter rule was not easy, and it accompanied the development and shifts in the notion of actuarial fairness. The term "unfair discrimination" was coined in 1909 by the Commissioner of Kansas to mean "charging different rates to persons with risks of a *like kind and hazard*" [Miller 2009: 278, emphasis added]. It might be interesting here to pause a moment and realize that the rule was not meant to promote differentiated rates; on the contrary, it was meant to prohibit *certain kinds* of differentiation. The limit case of one single rate for all is perfectly fair according to this definition. The principle takes as a given the similarity of risks, and imposes an equality of rates. In practice however, that similarity is a construct conditioned on the data available, and therein lies the difficulty.

In 1921, the new regulation concerning workers' compensation led President Mowbray[6] to devote his two presidential addresses of the year to the issue of insurance rate legislation, and to provide a first interpretation of unfair discrimination. Some were convinced that the regulation amounted to undue interference with the freedom of contracts and healthy competition mechanisms. Yet others, among them the President, recognized the necessity of public intervention, on at least two grounds. First, an examination of unregulated fire insurance premiums showed that rates were often unfairly discriminatory, the largest insureds having a greater negotiating power than the smaller ones. Fairness is here equated to an "*equitable distribution of the loss burden*," that is not obtained by "healthy competition." Second, since brokers and agents were paid by insurance companies, competition between the latter actually led to an increase in commissions and expenses, and not to reasonableness and adequacy. However, the real issue with the regulation was that there were no "standards of judgment" to determine rate adequacy or fairness. That was left to the discretion of local commissioners [CAS Proceedings 1921, vol. 8: 9-11, emphasis added]. In his second address, engaging all to adopt a "social viewpoint," Mowbray further extends the need for public intervention based on the *social* value of specific insurance products that justifies the combined action of the state and insurance companies in their promotion [CAS Proceedings 1921, vol. 8: 184-185, emphasis added]. It is on this basis that the workers' compensation act was adopted and rendered compulsory.

[6] A.H. Mowbray, fifth president and a charter member of the CAS, was a member of the National Council on Workmen's Compensation, before becoming professor of insurance at the University of California in 1923.

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While workers' compensation insurance was new, a classification of occupations existed since the beginning of the 19th century, through censuses [Hacking 1982]. In 1880, the census collected occupations in 235 classes [Truesdell 1965: 16]; in 1914, it included more than 1,500 classes. This posed a series of issues for actuaries trying to price the newly introduced workers' compensation product, and helped situate the technical constraints of the time. Indeed, on the one hand, the precision of the classification allowed rates to be adjusted to the specificity of each kind of risk, which fits a certain definition of adequacy and fairness; on the other, the level of granularity provided limited significance to each of the cells, which could make the overall scheme grossly inadequate. As demonstrated above, insurance needs regularity, and that can only be achieved with sufficiently large numbers. When the granularity is too refined, regularity disappears. In 1914, following a paper published in the press by Rubinow, the Massachusetts Insurance Department therefore recommended the grouping of occupations into 150 classes rather than the existing 1,500 [CAS Proceedings 1914, vol. 1: 12].

The first article of the proceedings, entitled "Scientific Methods of Computing Compensation Rates," again by Rubinow, provides a detailed account of the dilemma at stake. On the one hand, the very granular classification "results from the praiseworthy effort *to do justice to each line of industry*, *to charge it no more than its hazard requires*." In addition, the grouping of occupations according to a similarity of hazards implies an intervention that the actuary cannot perform: "*what do we know of exact measurements of hazard?* That is the very thing that experience must in the future produce. For hazard is not to be measured by the *likelihood* of producing accidents, but by *the actual causation of such hazards*" [CAS Proceedings 1914, vol. 1: 14, emphasis added]. Finally, competition imposes granularity: "it is almost impossible to oppose this tendency towards fine distinctions, for if rough grouping were insisted upon, the way would be open to the competitor to select the least hazardous subdivisions of each classification, and underbid on them" [CAS Proceedings 1914, vol. 1: 11].

On the other hand, however, the disparity of schemes among the states, added to the granularity of the existing classification and the changing industrial context, was such that "the possible exposure in one classification will be insufficient in one state to produce an average, except in so many years, that meanwhile conditions may entirely change, and make the accumulated experience entirely useless" [CAS Proceedings 1914, vol. 1: 12]. The only way to remedy the problem was to combine the experience nationwide and compare the results per

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industries and states; he therefore pleads for the constitution of a "statistical union of casualty business" [CAS Proceedings 1914, vol. 1: 23]. A few points are striking in this article: the first is the striving for scientific neutrality—while Rubinow makes clear that he is in favor of the grouping of classes, he compellingly exposes the arguments against it—again, mainly competition; the second is the faith in the possibility of attaining accurate knowledge of "causality," rather than simple "likelihood", thanks to the collection of statistics over time.

The reflection is continued the following year, with additional arguments in favor of the grouping of classes. The author, E.H. Downey, for a time special deputy of the Pennsylvania Insurance Department, was involved in the implementation of workers' compensation in that state.[7] The first objection to the 1,500 classes was that they reflected commodities but not hazards, and resulted from ad hoc intuitive and arbitrary divisions. Second, the limited amount of exposure in each cell makes the average cost per cell (the pure premium) very unstable from one year to the next. Sufficient exposure could be obtained over time, but rapid changes in industry made it impossible to create a long time span. The classification was therefore impracticable:

> The compiled experience of Massachusetts [...] indicates that five years' time will give an adequate exposure for about thirty of the 1,500 manual classifications. Wisconsin, in the same length of time, should accumulate a sufficient experience for some ten or fifteen risk classes. In New York, with its enormous and highly diversified industry, should fare much better, yet it needs no prophet to foretell that even New York State will fail to obtain a dependable pure premium on more than a small minority of the present risk classes [CAS Proceedings, 1915, vol. 2: 15].

He therefore recommends a grouping into 100 classes, and concludes:

> The common objection on the score of inequity is, for the most part, a misconception. *That every commodity shall bear its specific accident cost and every consumer pay his exact quota of the total is neither practically attainable nor especially important [...] The prime desideratum is that the cost of work accidents shall be distributed over the whole community* and the prime requisite to this end is that competing entrepreneurs shall be placed upon an equal footing [CAS Proceedings 1915, vol. 2: 18, emphasis added].

To the long-term idealistic adjustment of premium to risk evoked by Rubinow, Downey strongly opposes the impracticability of the theory and another conception of equity: "that the cost of work accidents shall be distributed over the whole community." Besides, he confirms that the

[7] He later published a book defending a very comprehensive cover [see Woodbury 1925].

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adequacy of rates to the specificity of the risk is rather a competition constraint, or a problem of fairness *between insurers*. The only objection to the grouping is thus not equity, but the danger posed by competition to the rate adequacy: if one insurer was in a position to isolate and attract a better segment within a given class by lowering its prices, the equilibrium would be broken since the other members would then not be paying enough to cover their losses.

Hence in its first years of existence, the CAS affirms the principles of a grouping that appears both as scientific and fair: the actuary has a social mission to fulfill. Although I will focus below on the evolution of the practice in auto insurance, the issues of segmentation, competition and fairness should be seen as reflecting the insurance practice as a whole.

The slow deconstruction of solidarity

At the beginning of the 1920s, the need for a motor liability insurance was driven by the same social concern that impacted work accidents 20 years earlier. Statistics were presented to the Society as early as 1922 to show the drastic increase in road fatalities and to propose options for accompanying a possibly compulsory automobile insurance [CAS Proceedings 1922, vol. 9: 23-37].[8] Yet, in contrast to the situation in workers' compensation, no classification was a priori available when the first motor insurance products were elaborated, therefore the interest of this line of business for the purpose of this paper. In addition, Massachusetts was the first state *in the world* to establish compulsory liability insurance in 1927. It therefore had no existing examples to guide it [CAS Proceedings 1926, vol. 12: 210]. To start with, the existing classification was very basic: the territory, four classes of use, three classes of cars based on engine power [CAS Proceedings 1921, vol. 8: 35-53]. For the universal insurance, consideration was even given to having one flat rate for all [CAS Proceedings 1926, vol. 12: 210-211], which, as mentioned above, was a perfectly fair practice in view of the Commissioner's

[8] The issue of compulsory liability insurance is raised time and again in the proceedings of the 1920s. Some schemes seem to have become compulsory in certain localities for specific cars such as public passenger vehicles or commercial trucking as early as 1921 [CAS Proceedings 1921, vol. 8: 11-12; 1922, vol. 9: 33]. Massachusetts was the first state to establish a compulsory insurance *for all* in 1927: in practice, the law required that the owner of a vehicle provide security for his liability, either through insurance, a surety bond or a security deposit [CAS Proceedings 1926, vol. 12: 188].

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wording. The driver's characteristics were not taken into account in these first rating plans, implying a pooling between very large groups.[9]

There was, however, a strong suspicion that the broad classes thus defined did not reflect homogeneous risks and might lead to moral hazard:

> Where careful and careless, efficient and inefficient drivers are all placed on an equal footing, there may be a tendency for the careful, efficient driver to relax to some extent the precautions which he has always observed. If these reactions take place, the frequency of automobile accidents will increase [CAS Proceedings 1926, vol. 12: 213].

In 1929, moral hazard appears again as an issue for the rating plans: "I refer to the difference *in mental viewpoint and moral standards* between drivers which will be reflected in part by their accident experience, as well as the difference in 'claim consciousness' *found in various communities*" [CAS Proceedings 1929, vol. 16: 273, emphasis added]. These differences were still not taken into account in the official rates. Interestingly, however, these hazards were associated with belonging to specific communities, hence putting the blame on the group rather than the individual. As a remedy, "merit rating," i.e. the claims history of the driver, was evoked as a possible classifying criterion as early as 1926. But it was conditioned on data to be collected and shared among companies, a major logistical challenge at the time [CAS Proceedings 1926, vol. 13: 191].

In addition, some commissioners, for example the Canadian one, suspected that agents were granted margins for manual adjustments, thus provoking unfair discriminations:[10]

> Two neighbors, a man and woman, residing door to door in the city of Toronto, insured their Ford sedans through different agents with this insurer within a few days of each other, no change in rating policy having taken place in the meantime. *A scrutiny of the written applications showed the risks as alike as two peas in a pod*. The woman paid a thirteen per cent higher rate than the man. The only

[9] Before the scheme became compulsory, the underwriters were in charge of selecting the risks and declining insurance to those deemed improper. The extent of this selection is not measured. The underwriter's task is "to see that the risks assumed by his carrier are *of good moral and physical hazard*. In the accomplishment of this objective he must be reasonably free to decline to insure certain risks" [CAS Proceedings 1926, vol. 12: 211, emphasis added]. This practice is similar to medical selection in life insurance, although it is not based on medical records [for an exhaustive description of medical selection in life insurance at the beginning of the 20th century, see Bouk 2015, 55-88].

[10] From time to time, the Society invited actuaries from other associations to present papers; the casualty actuary of the Ontario Department of Insurance was invited twice in 1932 and 1933. Other instances (not exhaustive) are the invitation of a French actuary in 1931 to present "marriage and birth insurances" products; the invitation of a British actuary in 1959 to present a review of compulsory auto insurance in Europe.

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> explanation of the discrimination on the daily report was "Premium arranged by A.H.B." [CAS Proceedings 1932, vol. 19: 31, emphasis added].

By the end of the 1930s, various plans had been adopted to account for some characteristics of the driver, either based on claims history, or mileage, or both [CAS Proceedings 1939, vol. 26]. In a lengthy debate entitled "informal discussion" in the 1939 proceedings, the actuaries considered whether or not such plans were unfairly discriminatory. Prof. Ralph Blanchard from Columbia University provided the principal argument: merit rating consists in giving discounts at renewal to drivers free of claims for one or two years. It thus rates "*individual* motor cars and *individual* drivers." The main argument against this practice, which was induced by competition, was unfair discrimination "because such experience is no indication of the hazard of the individual risk." In line with sound actuarial theory, the individual risk cannot be known, except as a member of a class. There is something arbitrary in the merit selection, magnified by the fact that the discount was conditioned on the bookkeeping practices of the insurance carrier [CAS Proceedings 1939, vol. 26: 358-359].

In opposition to this, it was argued that the new plans actually tried to create *new classifications*. The discount was applied as an alternative rating plan, "its effect is a classification plan which recognizes the fact that those who have had one accident have a greater probability of having another one," *as a group* [CAS Proceedings 1939, vol. 26: 365]. While the question was raised as to whether the new classes were not simply driven by competition, the conclusion was that the practice remained fair:

> No procedure which treats *all risks of a given class identically is unfairly discriminatory*. Legislation against unfair discrimination was enacted for the purpose of prohibiting practices which would afford to one assured treatment which another assured *identically situated* could not secure [CAS Proceedings 1939, vol. 26: 362, emphasis added].

The definition of "identically situated" does not refer here to an actual risk, but to the assignation into a class. Hence a further classification by sex in the above Canadian example would have rendered fair what was considered unfair: by introducing gender into the rate structure, the cells of pooling were simply rearranged in a new systematic, *thus fair*, manner. Classification was thus equated with fairness, blurring the issues of solidarity and pooling beyond the segmentation itself.

The focus on classification took on a new momentum after the war, seeming to go further and further away from considerations of solidary

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fairness. Indeed, the examination of auto liability rates during the second half of the 20th century shows a spiral of segmentation mostly driven by competition. The first comprehensive study of the impact of age was presented to the Society in 1950, endorsing *the technical necessity* of separating drivers below and above 25 years of age [CAS Proceedings 1950, vol. 37: 43-56]. Such a segmentation was based on statistical results, eschewing considerations of fairness. Indeed, the author stated that the "statistical results speak for themselves" [CAS Proceedings 1950, vol. 37: 52].

First introduced by one company in one state in 1949, segmentation by age was generalized to most companies and states one year later. After 1950, the classification of drivers was slowly enlarged to include marital status and sex, and to distinguish students, parents of children, occasional drivers and so on [Austin 1983; see also CAS Proceedings 1957, vol. 44: 19-44]. This refined classification was justified in 1957 by Joseph Muir, a senior actuary working for the Mutual Insurance Rating Bureau, on two grounds. The first was competition, that prevailed upon the solidary approach:

> In a market involving broad groupings of hazards, with a sufficient volume of business in each group to provide ample writings, a proper loss ratio incurred on a "disproportionate share" would be just as acceptable as on a "proportionate share." *Such a market, however, does not remain static. The forces of competition operate to narrow the groupings*" [CAS Proceedings 1957, vol. 44: 21, emphasis added].

The second was *fair discrimination*, the meaning of which had evolved during his career:

> More than a quarter of a century has passed since a student of the automobile liability insurance business stated that any advantage occurring from improvement in the loss experience should go to all policyholders, and conversely, any adverse development should be apportioned among all risks. This theory was predicated on the following precept of insurance: "A group of persons, each of whom realizes that he is subject to the possibility of some loss, *the time and amount of which are matters of uncertainty*, create, through justly proportioned contributions, *a common fund*, from which, in the event of such loss happening to any of them, compensation may be made to the loser and the burden thereof distributed *over the entire group*." *The philosophy of distributing loss experience among all insureds, irrespective of risk hazard, no longer prevails to any extent*. It has been rejected in favor of a policy of *fair discrimination with respect to rating criteria which are measurable in terms of loss costs* [CAS Proceedings 1957, vol. 44: 19, emphasis added].

The principle of "fair discrimination" was here interestingly changing. Anchored on the *measurement* of risk according to rating criteria, hence segmentation, it became a matter of computation capacities, rather than a "philosophy" of shared losses.

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In his study of the various classification plans in 1960, Robert Bailey[11] noted that competition was pushing towards more selection, obtained through the combined endeavor of actuaries and underwriters. Yet, however complex the system had become, it only explains half of the overall variation, thus leaving room for better models to be implemented [CAS Proceedings 1960, vol. 47: 35]. The spiral of segmentation was therefore slowly erasing the perspective of fairness as the sharing of risk among broad classes in favor of a "scientific" approach that aimed at an ideal of perfect adjustment to each individual hazard. Bailey concluded that "it is probably safe to say that we will never be able to devise a classification system which will produce a *precisely correct rate for each risk*, but *we attempt to come as close to this ideal as is possible and practical*" [CAS Proceedings 1960, vol. 47: 30, emphasis added].

The possibility of attaining such an ideal became conditioned on theoretical and technological progress. Technically, a new step was reached in 1972 with the emergence of the Generalized Linear Models (GLM) that offered a new way of refining classes based on an analysis of variance [Nelder and Wedderburn 1972; Coutts 1984]. In practice, these models started to be implemented in the 1990s. Yet however sophisticated the GLM models are, they still rely on a group approach; the most granular level of risk is the intersection cell of the various classifying variables.

The big data era, by contrast, bears the potential of a paradigm shift in classification, one that might deliver the final blow to solidary fairness. Indeed, the "datafication" of the world [Mayer-Schönberger and Cukier 2013] means that data may now be collected seamlessly via sensors without the need for questionnaires. The necessary homogenization resulting from the limited amount of categorical information collected is a priori replaced by the infinite possibilities of combining meaningless traces [Rouvroy and Berns 2013] and "digital bread crumbs" [Pentland 2014: 8] for the sake of personalization. While the information remains dependent on a priori definitions of events and thresholds, hence on a "categorization all the way down" [Fourcade and Healy 2017 289; see also Kitchin 2014], the individual score resulting from the fine grained assessment, I would argue, conveys an imaginary of the collective that is radically different from the one derived from broad categories and classes, accordingly changing the conception of fairness.

[11] Robert Bailey and his father Arthur Bailey, also an actuary, both contributed to the important introduction of "credibility theory" in non-life actuarial practice, i.e. a Bayesian approach that helped legitimate merit rating, and was instrumental in its being integrated in most rating plans in the second half of the 20th century [Bryan 2014, 34].

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Big data and changing conceptions of fairness: finding homogeneity

While actuarial fairness seems to haunt the rating principles that were expressed time and again in the CAS proceedings—mostly under the traditional yet vague injunction that rates should not be "unfairly discriminatory"—the notion was obviously evolving over time: once based on broad solidarity, it had become an issue of respecting the classification, the latter becoming more refined over time due to competition. Fairness finally takes its current meaning of "adjustment to the *individual* risk" in several papers presented at the beginning of the 1980s. They came as a response to the "classification controversy" that took shape in the United States in the 1970s, when several class actions were brought against the use of specific parameters (e.g. sex) for insurance pricing [Austin 1983; Avraham 2017]. The controversy emerged thanks to the efforts of individuals and groups (consumers associations) in questioning the classificatory practice of insurers. The arguments, however, suffered from incoherence and disunity, asking altogether for more granular segmentation[12] and for broader pools in order to limit price differentials [Austin 1983: 519]. The controversy was particularly problematic for actuaries since it questioned the very basis of their practice: identical pricing for all the members of a class. What had become the profession's precise definition of a fair discrimination was attacked as unfair, on the basis of the non-homogeneity of the class.

A first paper presented at the CAS in 1979 by Richard Woll addressed the issue of homogeneity. Recognizing public concerns, he concluded as follows:

> In the future, actuaries will no longer be allowed to focus their attention exclusively on *mean class rates without explicit concern about the types of classes that they are defining and working with. There is valid public concern about the possibility that "good" risks may be paying more than they should for their insurance, while "bad" risks are paying less*. There is no evidence whatsoever that this is taking place, but our past inability to demonstrate that our classes are relatively homogeneous has troubled many reasonable people. Actuaries can hope to provide this reassurance only by developing objective measures and standards for class homogeneity [CAS Proceedings 1979, vol. 66: 119, emphasis added].

[12] For instance, in 1981 a judge claimed the following: "a rate structure based on age and sex, factors over which the driver has no control, unfairly discriminates against those individuals with good driving records who are forced to pay higher premiums because of membership in a class with a poor driving record" [1981 Louisiana ruling, quoted by Austin 1983: 529]. Austin also mentions the California Action League (CAL) that "ultimately, wants auto insurance rating to be assessed *on driving record only*" [Austin 1983: 528, emphasis added].

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Homogeneity was once a necessary and arbitrary assumption, a construct of the actuary's work; it became an object of knowledge, hence perceived as an objective feature of reality to be grasped and *a measure of the fairness of the classification*. It would also serve as a trigger for further segmentation. A second paper in 1981 entitled "Risk Classification Standards" by Michael Walters indeed took advantage of the controversy to reinforce the soundness of risk classification and to reject the state intervention that resulted from the controversy.

While he insists on the impossibility of "knowing" the individual risk, Walters also defends the idea that classification should strive for homogeneity, defined as "reflecting premium differences for identifiable and rateably different subsets within broader classifications" [CAS Proceedings 1981, vol. 68: 16]. This aim of adjustment is to be achieved by virtue of free competition since "it is obvious that the essence of competition will be to try to find rateable subsets of existing classifications to price *more accurately and equitably*" [CAS Proceedings 1981, vol. 68: 14, emphasis added].

Walters is further opposed to subsidies between groups of insureds and to state intervention in rate regulation, both of which are characterized as welfare. Insurance, by contrast, was a (an exact?) science that aimed at adjusting the premium to the risks via the classification: any regulatory interference with this principle is perceived as being "against *the use of knowledge* in a free society" [CAS Proceedings 1981, vol. 68: 17, emphasis added]. A failure to adjust the rates "would therefore be a subsidy by those with a lower loss likelihood of those with higher loss expectancy" [CAS Proceedings 1981, vol. 68: 16]. While no mention is made of neoliberalism, the principles are clearly stated to be in favor of competition, the absence of state intervention and, to the extent possible, the removal of subsidies between groups—a strange answer to the public's call for greater justice.

The article, which was awarded best CAS paper in 1981, actually redefines insurance practice, classification and actuarial fairness in contradistinction to welfare:

> Some may believe that insurance is an instrument of social policy to compensate victims. This view treats the premiums as merely a means of accumulating funds to pay out losses in ways *possibly fundamentally different from the relative risk that each insured presents to the pool*. But trying to do something noble via the premium collection facilities of insurers *does not make the resultant mechanism insurance*, as cited earlier. Insurance is what it is—the transfer and reduction of risk; it is not a tax to redistribute wealth [CAS Proceedings 1981, vol. 68: 5, emphasis added].

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Fairness as the solidarity between large and necessarily heterogeneous groups gives way to a notion of actuarial fairness in the form of the adjustment of rates to "individual risks," or at least to a pooling that is limited to the *exact same risks*. The solidarity, in this view, is then pure "chance solidarity," or probabilistic solidarity, where the insureds in the group share the same (known) frequency. This theoretical—and highly imaginary—formulation is conditioned on newly acquired technical capacities during the 1980s. Some (non-CAS) actuaries indeed contend that:

> In the past, it used to be very difficult to discover risk factors both in a qualitative and in a quantitative sense. Solidarity was therefore—unavoidably—considerable. But recent developments have changed this situation: *with the help of computers it has become possible to make thorough risk analyses, and consequently to arrive at further premium differentiation* [De Witt and Van Eeghen 1984: 155, emphasis added].

The distinction between two conceptions of fairness that has today become commonplace—between pure "chance solidarity" as the sharing of costs between *identical* risks and "subsidizing solidarity" as the sharing of costs between different risks [Thiery and Schoubroeck 2006; Liukko 2010; Lehtonen and Liukko 2011]—appears, therefore, as the result of technological developments, pushed both by competition and public pressure. Furthermore, the tension between statistical knowledge (requiring the stability of large classes) and competition (pushing for more segmentation) is now lifted. Technical capacities and neoliberal individualism both converge towards the individualization of risk calculations, which in turn feeds an imaginary where the community of fate in front of accidents is being erased.

One might then wonder whether the conception of fairness as (subsidizing) solidarity and welfare was not conditioned on the existence of a form of knowledge that is now becoming obsolete. Strongly relying on Rawls' *Justice as Fairness*, Ewald indeed suggests that, at their inception, pooling mechanisms relied on the assumption of a "veil of ignorance" concerning the true nature of the risk of each individual [Ewald 2014: 8; Rawls 2005]; the collective and statistical viewpoint was built as a science that disregarded individual specificities. As expressed in the first part of this paper, the observed regularity of random events at the population level constructed the collective point of view *on the impossibility to know individual hazards*. The veil that Ewald has in mind was therefore a structural one. Actuarial fairness by contrast assumes that some (all?) knowledge of individual risks is accessible: besides not being equal, people are *knowable,* and fairness requires the use of this knowledge.

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Today, the possibility of collecting tremendous amounts of data on individual *behavior*, combined with new techniques aimed at attributing individual scores rather than working on averages [Siegel (2013) 2016], revives the utopia of adjusting premiums, offers, or products to the specific individual. The issue has been widely analyzed with respect to marketing procedures [Turow 2012; Turow and Draper 2014; Pasquale 2015]. In his study of fictional expectations and their influence on decision making, Beckert insists on the way in which macroeconomic forecasts, as fictions of the future, help orient economic action [Beckert 2016: 217-244]. With the advent of big data technologies and predictive analytics, the practice of forecasting is transformed, I would suggest, from the production of macroeconomic visions to the inference of individual propensities to specific actions. Statistical knowledge achieved on aggregate is sometimes considered as obsolete in view of the new techniques that have emerged [Pentland 2014].

In insurance, the recent introduction of telematics products in car insurance is a case in point. The sensors allow for the collection of continuous data on the position, speed and acceleration of the car, therefore radically changing the type of information available for the purpose of risk measurement. The striving for individualized scores is justified on the grounds of increasing knowledge, availability of data and competitive pressure [Weidner, Transchel and Weidner 2017], but also of a more equitable pricing [Litman 2005: 49; Winlaw *et al*. 2019, 131; Verbelen, Antonio and Claeskens 2018; Bian *et al*. 2018]. A 2017 review of the existing models summarizes the hopes associated with the new devices as follows:

> In general, each driver could be assigned a probability of crash involvement *based on his/her driving behaviour*. Charging all drivers a lump sum leads to assume that the crash probability is equal across the entire population of drivers. Evidently, this does not *from a user optimum and socially equitable approach*, as *drivers with lower crash risk are forced to "subsidize" those with higher* [Tselentis, Yannis and Vlahogianni 2017: 140, emphasis added].

In their case study of a telematics product, Meyers and Hoyweghen further contend that this kind of product involves a shift from fair discrimination, which was still relying on a group approach, to a "behavior-based" fairness. In the latter, the risk has not solely been individualized in terms of price; the responsibility of the risk level is also returned to the insured, who could in theory take control on his premium by a proper driving behavior [Meyers and Hoyweghen 2018: 428-430].

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Conclusion

Insurance mechanisms have accompanied the construction of modern societies by offering novel tools to cope with uncertainty. The isolation of collective regularities that could not be explained at the individual level allowed for the distinction between individual randomness and collective risks, that could be measured on populations. This statistical knowledge was at the core of the welfare state that propelled a conception of fairness based on solidarity: since individual accidents are the fate of us all, they should be dealt with in common.

Such principles were put into practice by economists, statisticians and actuaries. However, an examination of the proceedings of the American Casualty Actuarial Society (CAS) shows that the practice of pooling hazards was never really finalized and was always conditioned on the technical capacities of the time. During the 20th century, the regulatory injunction that rates should not be "unfairly discriminatory" received changing interpretations. From a broad solidarity in front of increasing industrial or motor accidents, tools were slowly developed to create finer segmentation. Yet, while the original arguments in favor of segmentation were found in the constraints of competition, the striving for a better adjustment to "individual risks" was slowly understood as being fair, now defined as "actuarial fairness." This new conception was presented as a scientific goal that prevailed upon social debates.

The recent proliferation of new data and technologies, which enable increasingly finer personalization of products in every domain, further radicalizes the potential for this kind of fairness. Big data technologies indeed bear the potential of an epistemological shift from the collective apprehension of risks towards an individual one, based on scores and prediction. In insurance, connected objects allow for the development of new models, based on individual behavior rather than aggregate statistics. Big data technologies further propel a fictive expectation that risks could be managed by predicting individual risks rather than by estimating their average cost. By thus deconstructing the imagination of a community of fate, this shift further shakes the foundations of fairness as solidarity and puts back to the forefront the individual approach based on the fairness of a contract between an insured and an insurer. By doing so, fairness has been reduced to an algorithmic calculation, losing sight of the social issues that were involved in the first place.

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Résumé

Cet article montre comment les mécanismes d'assurance qui ont historiquement favorisé une conception de l'équité fondée sur la solidarité et une approche collective se sont déplacés au cours du XX^e^ siècle vers un ajustement idéalisé autour du risque individuel. À l'origine, les assurances partaient du principe que si les aléas individuels restaient inconnus, le risque pouvait être mesuré et géré globalement. L'examen des travaux de l'American Casualty Actuarial Society (CAS) au cours du XX^e^ siècle met en évidence la lente cristallisation d'une autre conception de l'équité, l'équité actuarielle, qui recherche un ajustement scientifique des primes d'assurance autour des "risques individuels" réels. Je considère que cette conception de l'équité déconstruit celle fondée sur la solidarité. Les technologies de données massives contribuent toujours plus à radicaliser ce changement. En produisant des scores de risque individuels prédictifs plutôt que des coûts moyens estimés sur une totalité, les algorithmes contribuent à remplacer l'équité comme solidarité par la justesse d'un calcul.

Mots-clés Big Data ; Classification ; Équité des assurances ; Solidarité ; Individualisation du risque.

Zusammenfassung

Dieser Artikel zeigt, wie sich Versicherungsmechanismen, deren Ursprünge auf eine ausgleichende Gerechtigkeit mit solidarischem und kollektivem Ansatz zurückgehen, im Laufe des 20. Jahrhunderts zu einer idealisierten Anpassung an individuelle Risiken weiterentwickelt haben. Ursprünglich galt für Versicherungen folgende Prämisse: selbst wenn individuelle Gefahren unbekannt bleiben, kann das Risiko global gemessen und gehandhabt werden. Ein Rückblick auf die Arbeit der American Casualty Actuarial Society (CAS) während des 20. Jahrhunderts verdeutlicht die langsame Herauskristallisierung einer anderen Definition von ausgleichender Gerechtigkeit, und zwar der versicherungsmathematischen Gerechtigkeit, mit dem erklärten Ziel einer wissenschaftlichen Anpassung der Versicherungsprämien an reale „individuellen Risiken". Ich bin der Meinung, dass diese Vorstellung von Gerechtigkeit die auf Solidarität beruhende dekonstruiert. Massive Datentechnologien tragen zunehmend dazu bei, diesen Wandel zu radikalisieren. Wenn prädiktive individuelle Risiko-Scores anstatt geschätzter Durchschnittskosten einer Gesamtgröße genutzt werden, führen Algorithmen dazu, dass die solidarisch getragene Gerechtigkeit durch die Richtigkeit einer Berechnung ersetzt wird.

Schlüsselwörter: Big Data; Klassifizierung; ausgleichende Gerechtigkeit der Versicherungen; Solidarität; Risikoindividualisierung

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