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Big Data, Insurance and the Expulsion from the Garden of Eden

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The advent of big data, fuelled by declining data-storage and processing costs as well as increasing connectivity, fundamentally changes the environment in which insurance operates. Every year, more data is produced than in the entire previous history of humankind. The rapidly growing availability of data is likely to enhance the economic and societal contribution of insurance by improving insurers' understanding of risks, enhancing the efficiency of the insurance mechanism and by increasing the effectiveness of risk prevention and mitigation. In fact, data analysis has always been at the root of the insurance business model.

Big data, however, also raises a number of concerns. These do not only involve ethical and societal concerns about privacy, data protection and 'unfair' discrimination, but also questions about the welfare consequences. In insurance, for example, the deployment of big data technologies is likely to result in a greater differentiation of insurance premiums based on individual risk characteristics. The welfare implications of such risk classifications are far from obvious and require detailed economic analysis. In recent years, such concerns have led regulators in different jurisdictions to impose bans on the use of certain information for underwriting purposes (see, for example, the EU Gender Directive or the debate on the use of credit scores in the U.S.).

This article uses standard economic welfare analysis to consider the implications of enhanced risk understanding versus banning the use of risk information in the underwriting process.[1] For the purpose of this analysis, we uniquely focus on the welfare implications of risk classification and do not consider broader concerns about privacy and data protection. The motivation of this analysis is to develop an analytical framework to evaluate the efficiency implications of different policy choices.

Life in Eden: the value of premium risk insurance

We refer to 'Eden' as a situation in which no one (neither insureds nor insurers) knows about individual risk characteristics. Take life insurance before the invention of genetic testing as an example. A holder of a specific gene may have a high risk for developing a certain illness, but neither he nor the insurer knows about this. Hence, all individuals pay the same premium rate, irrespective of whether they are holders of a specific genetic predisposition or not.

Now suppose that we bite into the apple of knowledge, and both insurers as well as the insured learn about individual risk characteristics. Insurers will use this knowledge to differentiate premiums between high- and low-risk individuals. Low-risk individuals clearly benefit from this scenario, as they now pay a lower premium,

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1 Big data analytics may be applied in different stages of the insurance value chain, including customer insights, claims management and servicing, and risk selection and pricing. This paper uniquely focuses on the latter.

while individuals with a specific genetic predisposition will have to pay a higher rate. However, *ex ante* (i.e. before information about risk types is available), individuals may prefer to stay in Eden for fear of being revealed as a high risk. The absence of individual risk information thus acts as a protection against the risk of being revealed as high risk and having to pay a high insurance premium. We will refer to this in the following as 'premium risk insurance'.[2] Risk-averse individuals will typically value this insurance. As a result, for risk-adverse individuals, the expulsion from Eden would lead to an overall loss of welfare.[3] But also insurers may benefit in Eden: they not only sell an additional insurance (the insurance against premium risk) and earn additional premiums, they also save costs for risk assessment. The value of premium risk insurance to individuals will increase with the degree of risk aversion and the uneven distribution of risk types.

In reality, however, we hardly ever observe any 'Eden' insurance markets. In many cases, individuals have at least a sense of their risk type. Moreover, both insureds and insurers may have an incentive to bite into the apple of knowledge to get an information advantage. This information advantage would enable them to engage in adverse selection behaviour.[4]

Escaping Eden: the impact of adverse selection

As has been shown by Dionne and Rothschild (2014) and others, as long as the insurer cannot use risk-sensitive information and or is not allowed to differentiate insurance premiums, asymmetry of information can cause adverse selection, with high social costs.[5] Suppose individuals now know their risk types, and insurers are banned from using risk information. As high- and low-risk individuals would pay the same premiums, this may give rise to the classical adverse selection scenario: the premium rate set by insurers is unattractive to low-risk types and they will stop buying insurance coverage. As a result, the average losses of the remaining risk pool will increase, and so will the premium, which will trigger additional low-risk individuals to drop out.[6] In equilibrium, only high risks will buy insurance, and for low risks, there will be no insurance coverage. From a welfare perspective, this situation is clearly inferior to risk-adjusted premiums. Adverse selection represents a social cost that must be taken into account in the design of regulatory policies.

The cost of adverse selection will depend on whether low risk-individuals will choose not to buy the uniform insurance protection. This is the case when risk aversion, and therefore the individual benefit from being insured, is low or the expected loss of the entire pool is significantly higher than the expected loss of low-risk individuals.

Knowledge as the architect of fortune

While biting into the apple of knowledge may reduce the value of premium risk insurance, there may also be important benefits. In particular, knowledge about different risk levels and premium rates that reflect those risk levels may provide an incentive to invest in mitigation. In order to reduce their risk, individuals can build their property in a different location, install sprinklers, change their lifestyle or have preventive medical treatments.

In a world without insurance, they would be rewarded by the reduced level of risk and expected losses. Hence, they would want to invest in risk mitigation as long as the utility gain from the reduced risk outweighed the costs. However, if individuals were insured, they would only invest in risk mitigation if the measure led to a premium risk reduction that outweighed the costs. This can only be the case if premiums are risk sensitive. Then risk mitigation

2 The premium risk insurance is sometimes referred to as the 'solidarity principle'. We prefer the term 'premium risk insurance', as 'solidarity principle' usually implies some form of voluntary or involuntary redistribution, which is not the case here.
3 See, for example, Hoy (2006).
4 In principle, insurers also have an incentive to get an information advantage and to provide insurance protection only to low-risk individuals. However, this equilibrium is unlikely to be sustainable, as their customers will learn that they are low risk and will therefore ask for lower premiums. As a result we would end in an equilibrium without premium risk insurance.
5 See Dionne, G. and Rothschild, C. (2014).
6 Villeneuve (2003) demonstrates for the case of annuities and life insurance that adverse selection can also occur in the form of a higher demand by the worst risks.

leads to an increase in individual and aggregated utility. If the net gain from risk mitigation is large enough, the aggregated utility can even exceed aggregated utility in Eden.

Conclusions

The welfare effect from banning the use of risk information by insurers depends on the net effect between the gain from premium risk insurance, the cost of adverse selection, and the loss of risk mitigation incentives. These elements can differ significantly between different kinds of insurance products. Hence, from an economic welfare perspective, there is no general answer to the question whether the use of risk information should be banned or not.

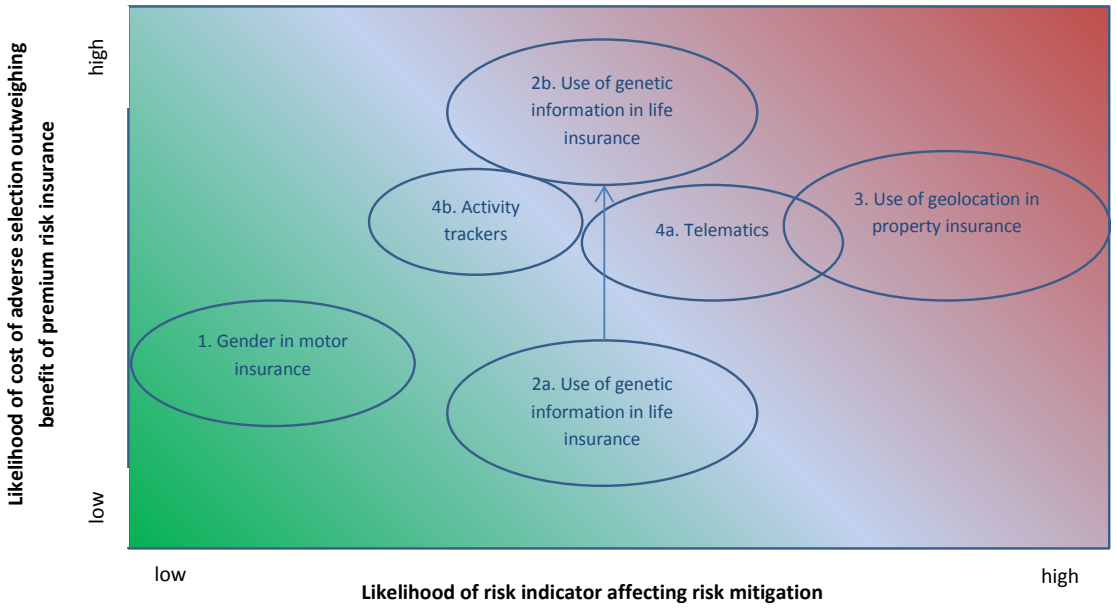
In the following, we apply our framework to a number of different cases for illustrative purposes. These case studies represent only a first cursory assessment. More in-depth quantitative research would be necessary to come to a definitive conclusion of these cases:

- **Banning the use of gender information as a risk indicator in motor insurance:** The value of premium risk insurance is medium high, as risks do not differ very strongly between women and men. On the other hand, adverse selection costs do not seem to be a major issue. In most countries, motor insurance is mandatory and, therefore, adverse selection is eliminated. Even in the absence of mandatory insurance, adverse selection costs seem to be moderate: as the maximum loss can be substantial, especially with respect to third party liability, the value of insurance cover is arguably relatively high. In addition, it is unlikely that many men will change their gender in order to pay less on their motor insurance and that premium-rate differentiation between genders leads to any kind of risk mitigation. Hence, since costs from adverse selection should be moderate and since we cannot expect positive risk mitigation effects, it is unlikely that banning the use of gender as a risk indicator for motor insurance leads to a significant welfare loss.
- **Banning the use of genetic information for life protection products (mortality/disability):** Under the current circumstances, banning the use of genetic information by insurers provides a high benefit from premium risk insurance. At the same time, as most individuals do not possess genetic information, costs from adverse selection are currently low. This situation may soon change, however. It is expected that genetic tests will become affordable for a significant part of society and thus create the basis for adverse selection. Under these circumstances, banning the use of genetic information could lead to a reduction in welfare. Whether the use of genetic information incentivises risk mitigation has to be analysed case by case. Genetic information could allow for preventive actions to reduce the likelihood of the outbreak of a specific illness. In these cases insurers should offer a uniform insurance product which also covers the costs for risk mitigation.
- **Banning the use of geolocation as risk indicator in property insurance:** The location of a property has a significant effect on its exposure to natural disasters. Even though it may be difficult for individuals to correctly assess the risk exposure of their location, they usually know whether the risk is relatively high or low. Therefore, banning the use of geolocation as a risk indicator offers the possibility for adverse selection. Risk mitigation is important in managing the risks of natural disasters, either through informed decisions on new constructions or through investments into mitigation measures. Hence, banning the use of geolocation information in property insurance is very likely to reduce welfare. Risk-based prices may lead to affordability issues in highly exposed areas. Rather than ban the use of risk information, however, affordability issues should be dealt with using other measures if maintaining population in high-risk areas is socially desired. For example, one option would be to subsidise the insurance premiums of high-risk individuals.
- **Banning the use of telematics and health trackers to incentivise prudent behaviour:** New technologies have to potential to support and incentivise prudent behaviour by policyholders, thus reducing the overall level of risk. Telematics, for example, has the potential to positively affect prudent driving behaviour. A ban on the use of telematics in motor insurance would therefore likely reduce welfare. Compared to telematics,

premium incentives based on data from health trackers would arguably play a somewhat less important role in affecting behaviour by policyholders. It is, however, likely that particularly low-risk individuals will chose insurance solutions that use telematics and activity trackers, which increases the risk in the pool of traditional insurance products. Eventually, traditional insurance products may not be offered at all. At the same time, telematics and, in particular activity trackers, raise substantial privacy concerns.

As we have seen, whether a ban on the use of risk information in underwriting enhances or reduces welfare needs to be assessed on a case-by-case basis. Figure 2 summarises these results. In the bottom left corner, both the likelihood that a ban on using risk information creates adverse selection costs that outweigh the loss of premium insurance and the likelihood that a ban reduces risk mitigation incentives are low. Hence, a ban on using risk information is likely to be welfare enhancing. As we move towards the upper right corner, the likelihood that a ban enhances welfare decreases.

Figure 2: Likelihood of a ban on using risk information enhancing welfare (green = likely, red = unlikely)



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