Abstract

Telemonitoring devices, such as wearables in health insurance or a telematics system in car insurance, can be used to screen consumers’ characteristics and mitigate information asymmetries that lead to adverse selection in insurance markets. However, some consumers value their privacy and may dislike sharing private information with insurers. In a Wilsonian framework, we introduce the possibility for consumers to reveal their risk type for a certain subjective cost that differs across individuals and show analytically how this possibility affects the standard Wilsonian insurance market equilibria as well as social welfare. Our analysis shows that the choice of information disclosure with respect to revelation of their risk type can substitute deductibles for consumers whose transparency aversion is sufficiently low. The availability of a transparency contract does not break up an existing separating equilibrium and can lead to a Pareto improvement of social welfare. If a pooling equilibrium exists in the standard Wilsonian market, the equilibrium resulting from the introduction of a transparency contract depends on the fraction of transparency averse low risks. Given the prior existence of a pooling equilibrium, utility is shifted from individuals who do not reveal their private information to those who choose to reveal. The impact a transparency contract has on social welfare is ambiguous and depends on the composition of individuals in the market, with respect to their risk type and transparency aversion.

Keywords: Adverse Selection, Digitalization, Privacy, Screening, Transparency Aversion, Wilsonian Market Equilibria

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1 Introduction

It has long been known that monitoring and screening policyholders’ behavior and characteristics can reduce information asymmetries that lead to moral hazard and adverse selection issues in insurance markets. With the ongoing process of digitalization, new technologies are used to acquire, store and manage more information about consumers, aiming to price insurance policies more accurately and adjust the underwriting reserves for each policy according to the respective risk. One way to do so is using telemonitoring devices, such as wearables in health insurance or a telematics system in car insurance.

The U.S. health insurer Aetna announced in September 2016 that it will subsidize a significant amount of Apple watches for its policyholders of employer insurance contracts if they are used to collect health data for Aetnas analytics-based wellness and care management programs.1 The life and health insurer John Hancock offers discounts on premiums, various rewards and a free wearable with its Vitality program. On its website, individuals can calculate their vitality age2 by answering questions, among others, about eating habits, weekly hours of exercising, smoking habits, alcohol intake, height, weight, waist circumference, blood pressure, cholesterol and mental wellbeing.3

However, as the public discussion about consumer protection shows, consumers value their privacy and don’t feel comfortable sharing too much information with public institutions or companies, such as insurers.4 They exhibit a disutility from transparency or - in other words - a transparency aversion. The degree of this transparency aversion might differ among consumers but does not necessarily depend on whether consumers are "low risks" or "high risks". It is rather correlated with their valuation of privacy, their view on digitalization, cyber security, trust in companies and public institutions with respect to data abuse and related experience, and even their political orientation, e.g. their views on consumer rights. The disutility a consumer experiences depends on his

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2 A person’s Vitality Age should serve as an indicator of overall health and wellness and inform the insurer about a person’s mortality in a more comprehensive way than age does.
4 See for instance http://actuaries.asn.au/Library/Opinion/2016/BIGDATAGPWEB.pdf. Some public debates even go beyond a simple preference for privacy, as it is for instance displayed by the German author Juli Zeh. Her dystopian novel The Method (Zeh (2012)) describes a future health dictatorship, where laws are written in order to optimize population health.
preference for privacy and might be big enough to outweigh the utility increase from risk adequate insurance and prevent him from purchasing insurance. In that case, offering an insurance policy that requires policyholders to reveal private information in a market with imperfect information does not attract all individuals with a low probability of loss and does therefore not work as an ideal screening mechanism. Insurers might not be able to distinguish whether consumers do not wish to reveal private information because they exhibit a high loss potential or a high transparency aversion. The price for an insurance policy that does not require policyholders to reveal private information then might depend on the availability of an insurance contract that does require this information as well as on the number of consumers choosing such a contract. With a heterogeneous valuation of privacy among consumers, transparency averse individuals might suffer a social disadvantage by digitalization.

In a theoretical framework, we investigate whether and in which way digitalization affects the standard results for insurance market equilibria, given that consumers exhibit heterogeneous transparency aversion in the absence of moral hazard. Within the Wilson (1977) framework, we introduce an insurance policy that offers full coverage at a fair premium, but requires the revelation of private information. We aim to show analytically how this affects the standard results regarding Wilsonian insurance market equilibria and analyze the resulting implications on social welfare.

The following Section 2 provides a short literature review. In Section 3, we introduce the theoretical framework of our model. Section 4 presents the equilibria that emerge when introducing the fairly priced full coverage insurance policy that requires the revelation of private information. Resulting implications on utilitarian social welfare are analyzed in Section 5. Section 6 concludes and provides a short outlook on potential future research.

2 Related Literature

We build our model on the standard literature on adverse selection. The widely referenced study by Rothschild and Stiglitz (1976) analyzes insurance market equilibria in the context of perfectly competitive insurers and two types of consumers: Individuals with a high probability of loss and individuals with a low loss probability. Insurers cannot observe consumers’ risk types. The market equilibrium outcomes in this model depend on the fraction of high-risk individuals. If this fraction
exceeds a critical value, a pooling contract priced at the average risk does not attract low-risk consumers and therefore the market equilibrium is described by two self-selecting separating contracts. If the fraction of high risks exceeds the pivotal fraction, there is no market equilibrium because competitors could always attract low risks with a more attractive contract. Wilson (1977) modifies the assumptions in a way that an insurer can anticipate which policies offered by competitors will become unprofitable as a result of changes in its own policies. He assumes that unprofitable policies will be withdrawn and adjusts its supply accordingly or withdraws own policies if they in turn become unprofitable. This property ensures the existence of an equilibrium. If a separating equilibrium in the sense of Rothschild and Stiglitz (1976) (RS) exists, the Wilsonian equilibrium equals the RS separating equilibrium. Otherwise, the market is described by a Wilsonian pooling equilibrium. In either case, the market equilibrium is not efficient in terms of risk allocation, since low-risk individuals receive only partial coverage.

Several studies focus on how screening policyholders' characteristics can mitigate inefficient information asymmetries (e.g. Crocker and Snow (1986), Crocker and Snow (2011), and Dionne and Rothschild (2014)). Some (e.g. Hoy (2006)) also look at the implications of screening on social welfare. Browne and Kamiya (2012) analyze a framework in which consumers can purchase an insurance policy that requires taking an underwriting test and sharing the results with the insurer. In a Wilsonian market with nonmyopic insurers, they show that offering such policies leads to the existence of underwriting equilibria in which low-risk individuals obtain greater insurance coverage than they would in a setting without underwriting test. The authors consider a positive fee for the underwriting test but do not take into account consumers' valuation of privacy. Filipova-Neumann and Welzel (2010) name two potential reasons for disliking the revelation of private information: (1) The premium risk that individuals face if they are not informed about their own risk type (2) The inherent disutility from giving up privacy. Whilst several studies have analyzed the first case, oftentimes in the context of medical checkups or genetic testing (e.g. Doherty and Thistle (1996), Doherty and Posey (1998), Hoy and Polborn (2000)), the number of academic articles focusing on the second case has recently been increasing as well in various fields. Acquisti et al. (2016) point out that "exploiting the commercial value of data can often entail a reduction in private utility, and sometimes even in social welfare overall". Among other personal costs, they name quantity discrimination in insurance markets, the risk of identity theft and simply "the disutility inherent
in just not knowing who knows what or how they will use it in the future.” Filipova-Neumann and Welzel (2010) examine the effects of monitoring technologies in automobile insurance markets with adverse selection, such as cars with ’black boxes’. In addition to the usual second best contract, they introduce a contract that gives access to recorded information to the insurer after an accident. The authors show that offering this kind of monitoring technologies can lead to a Pareto improvement of social welfare in an automobile insurance market with asymmetric information. In one scenario of their analysis, Filipova-Neumann and Welzel (2010) account for privacy concerns that are represented by a loss of utility for a fraction of low risks that is defined as having an inherent preference for privacy. In their model, the preference for privacy does not change their main result. However, in their setting, data is retrieved and analyzed only when the driver reports an accident. Therefore, an ex-ante classification of risks is not possible. The adjustment to the respective risk type that is revealed by the ’black box’ is displayed in an ex-post adjustment of the indemnity payment rather than an ex-ante premium adjustment. Filipova-Neumann and Welzel (2010) follow the standard assumption in the asymmetric information literature allowing for only two types of consumers: low risks and high risks. Within the fraction of low risks, the authors assume that consumers either exhibit a preference for privacy or do not, but the level of privacy concerns does not differ across individuals. These two assumptions are relaxed by Hollis and Strauss (2007) who consider a unique probability of having an accident for each consumer and a heterogeneous valuation of privacy, measured by a linear function of a loss of privacy.

We follow Browne and Kamiya (2012) in analyzing how the existence of insurance contracts that include screening possibilities with respect to consumers’ risk types affects the standard results in a Wilsonian market with nonmyopic insurers. To the best of our knowledge, we are the first ones to analyze the role of privacy preferences in this setting and its effect on market equilibria and social welfare.

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5 They analyze privacy concerns in a more extensive way in a previous version of this article (Filipova et al. (2005)), where they also consider individuals that are uninformed about their own risk type.

6 This setting can impact the correlation between transparency aversion and a low probability of accident. Transparency averse drivers who are also low risks could exhibit lower private costs from having such a black box installed than implied by their transparency aversion, since they know that the likelihood of having to report their data is small, if data is not reported at any time but only in the case of an accident.
3 The Theoretical Framework

3.1 Basic Framework

We consider an imperfect insurance market with asymmetric information. Individuals are endowed with initial wealth $w_0$ and face a loss of $D$ with probability $\pi_i$, where $i \in \{L, H\}$ and $0 < \pi_L < \pi_H < 1$. The loss probability is an individual’s private information. The fraction of high-risk individuals in the market is denoted by $\lambda$, whereas $(1 - \lambda)$ is the fraction of low risks. Individuals are risk averse with a twice differentiable concave utility function over final wealth $u(\cdot)$, i.e. $u'(\cdot) > 0$ and $u''(\cdot) < 0$. Risk neutral, nonmyopic insurers operate in a competitive market environment and offer insurance policies that are characterized by an indemnity payment $q$ offered in return for a premium $p$ paid by the policyholder. Due to perfect competition, the premium is actuarially fair and equals the expected value of the indemnity payment. Consumers’ private information can be retrieved at no cost, for instance through the implementation of technological monitoring devices. Whether or not this information is shared with the insurer, e.g. by implementing a telemonitoring device, is agreed upon before contract inception. For the sake of simplicity, we neglect insurer’s acquisition and administrative expenses. Every individual decides whether to reveal private information before contracts offers, i.e. the coverage $q$ and the premium $p$, are determined, anticipating the resulting effect on the latter. Consumers then choose whether to purchase the insurance product according to their individual expected utility.

3.2 Standard Policies

Following Crocker and Snow (1985) and Browne and Kamiya (2012), we denote the pivotal fraction of high risks in the market with $\lambda^{RS}$, i.e. a RS separating equilibrium exists, if and only if $\lambda \geq \lambda^{RS}$. If $\lambda < \lambda^{RS}$, the underlying market is described by a Wilson pooling equilibrium. For the case $\lambda \geq \lambda^{RS}$, perfect classification is possible.\(^7\) The insurance premium in this case is given by $p_i = \pi_i q_i$, where $i = H, L$. In the separating equilibrium $(H, L)$ with $H = (p_H, D)$ and $L = (p_L, q_L)$ low risks forgo a part of their utility because they do not receive full insurance coverage.\(^8\) The

\(^7\)From the standard literature on information theory (e.g. Rothschild and Stiglitz (1976), Wilson (1977)), we know that the second best contract (that is established under asymmetric information if the fraction of high risks is big enough) is self-selecting.

\(^8\)In the separating equilibrium, it has to be $q_L < D$ for high-risk individuals not to be attracted by the insurance contract designed for low risks.
high-risk individuals’ utility of a RS separating contract \( H \) is given by:

\[
V_H(H) = (1 - \pi_H) \cdot u(w_0 - p_H) + \pi_H \cdot u(w_0 - p_H + D - D) = u(w_0 - \pi_H D)
\] (1)

A low-risk individual’s utility of a RS separating contract \( L \) is given by

\[
V_L(L) = (1 - \pi_L) \cdot u(w_0 - p_L) + \pi_L \cdot u(w_0 - p_L + q_L - D) = (1 - \pi_L) \cdot u(w_0 - \pi_L q_L + q_L - D)
\] (2)

In the case \( \lambda < \lambda^{RS} \), the market equilibrium is described by a Wilson pooling contract \( M = (p_M, q_M) \). The pooling premium is given by: \( p_M = [\lambda \pi_H + (1 - \lambda)\pi_L]q_M \) and an individual’s expected utility of a Wilson contract \( M \) is given by:

\[
V_i(M) = (1 - \pi_i) \cdot u(w_0 - p_M) + \pi_i \cdot u(w_0 - p_M + q_M - D) = (1 - \pi_i) \cdot u(w_0 - \lambda(\pi_H - \pi_L)q_M - \pi_L q_M + q_M - D)
\] (3)

### 3.3 Policies with Screening Option

Similar to Browne and Kamiya (2012), we introduce a conditional contract that offers full coverage\(^9\) in exchange for the fair premium, if individuals are willing to share a sufficient amount of information to reveal their true risk type. That information can for instance be retrieved using telemonitoring technologies. The conditional contract is described by \( T_i = (p_i^T, D) \) for \( i = H, L \).

Since most policies do not ask for a specific payment for the telemonitoring device but rather pay for the data management as well as installation and maintenance of the devices out of their revenue, we assume that consumers who decide for a conditional contract \( T_i \) with telemonitoring do not have to bear specific costs for the devices. The premium for a contract \( T_i \) offered to individuals that

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\(^9\)Full insurance maximizes consumers’ expected utility.
have revealed their risk type $i$ by sharing private information is given by:

$$p^T_i = \pi_i D$$

(4)

The contract with transparency option offers full coverage at a fair price and therefore increases low risks’ monetary utility in comparison to either one of the contracts with partial coverage discussed in the previous subsection. However, we assume that policyholders’ utility from insurance is not only determined by their monetary wealth, but takes into account the individuals’ valuation of privacy and the resulting disutility from the level of transparency agreed upon at contract inception.

**Definition 1:** The disutility resulting from sharing private information for individual $j$ is described by $\psi_j \in [0, \infty)$.

The overall utility a consumer $j$ gets from purchasing an insurance product is described by

$$V(w_i, \psi_j) = U(w_i) - \psi_j.$$  

(5)

Individuals decide whether or not to purchase insurance by trading off the maximization of expected utility of monetary wealth against the minimization of disutility from sharing private information. The latter is modeled additively as a second attribute to the utility function.\(^{10}\) Hence, an individual’s utility of a contract $T_i, i \in \{H, L\}$ is given by:

$$V_{i, \psi_j}(T_i) = [(1 - \pi_i)u(w_0 - p^T_i) + \pi_i * u(w_0 - p^T_i + D - D)] - \psi_j$$

(6)

\[^{10}\text{The multiattribute value function results here simply from the sum of two utility functions with different arguments. For a comparison, see Eisenführ et al. (2010) or Keeney and Raiffa (1993). Numerous articles on insurance market equilibria have taken into account different types of consumers’ characteristics and have modeled them as a second attribute to the consumers’ utility function. This strand of literature considers characteristics, such as patience (e.g. Sonnenholzner and Wambach (2009)), overconfidence (e.g. Huang et al. (2010)), ambiguity aversion (e.g. Koufopoulos and Kozhan (2015)), and regret (e.g. Huang et al. (2016)). In the context of the valuation of privacy, this approach is taken by e.g. Filipova-Neumann and Welzel (2010).}\]
4 Equilibrium Analyses

4.1 Consumers’ Participation Constraints

In order to specify the demand for conditional policies $T_i$ with $i = H, L$, we investigate on the cases where individuals’ utility from the transparency contract is higher than their utility from an alternative contract offered to them.

**Lemma 1:** High-risk individuals will never have an incentive to choose the conditional contract $T_H$ and will therefore never reveal their private information, regardless of their transparency aversion.

**Proof:** See Appendix A.1.1.

For low-risk individuals, we have to differentiate between the underlying market equilibria, i.e. whether the alternative contract offered to them is a pooling contract or a separating contract.

Let $\lambda \geq \lambda^{RS}$, i.e. without the transparency contract, the market yields a Rothschild-Stiglitz (RS) separating equilibrium. Then low risks will decide for a contract with transparency if and only if:

$$V_{L,\psi_j}(T_L) > V_L(L)$$

$$\Leftrightarrow u(w_0 - \pi_L D) - \psi_j > (1 - \pi_L) \cdot u(w_0 - \pi_L q_L) + \pi_L \cdot u(w_0 - \pi_L q_L + q_L - D)$$

$$\Leftrightarrow u(w_0 - \pi_L D) - \psi_j > u(w_0 - \pi_L D - \mu^L_L)$$

$$\Leftrightarrow \psi_j < u(w_0 - \pi_L D) - u(w_0 - \pi_L D - \mu^L_L)$$

where $\mu^L_L$ is the low risks’ risk premium associated with the RS separating contract $L$.

The interpretation of Inequality 7 is straightforward: For an individual to choose the insurance contract with transparency, the extra utility gained from full insurance must exceed the disutility from giving up private information.

Let $\lambda < \lambda^{RS}$, i.e. without the transparency contract, the market is described by a Wilson
pooling equilibrium. Then the low risks’ participation constraint for the transparency contract is given by:

\[
V_{L,\psi_j}(T_L) > V_L(M) \quad (8)
\]

\[\iff u(w_0 - \pi_L D) - \psi_j > (1 - \pi_L) \cdot u(w_0 - p_M) + \pi_L \cdot u(w_0 - p_M + q_M - D)\]

\[\iff u(w_0 - \pi_L D) - \psi_j > u(w_0 - p_M - \pi_L D + \pi_L q_M - \mu^M_L)\]

\[\iff u(w_0 - \pi_L D) - \psi_j > u(w_0 - \lambda(\pi_H - \pi_L)q_M - \pi_L D - \mu^M_L)\]

\[\iff \psi_j < u(w_0 - \pi_L D) - u(w_0 - \lambda(\pi_H - \pi_L)q_M - \pi_L D - \mu^M_L)\]

where \(\mu^M_L\) is the low risks’ risk premium associated with the Wilson pooling contract \(M\).

The extra utility gained from full insurance and not having to subsidize the high risks must exceed the disutility from giving up private information.

If conditions (7) or (8) are fulfilled in the respective underlying market situation, low-risk individuals reveal their risk type in order to purchase the insurance product \(T_L\). This leads to symmetric information between those consumers and insurers. In other words, those low risks drop out of the pool of unidentified risks and receive full coverage at a fair price.

### 4.2 Transparency Aversion Among Consumers

Since our results would not be comparable to the results of the standard asymmetric information literature, if we considered a continuous range of transparency aversion among possible insurance buyers, we look at the two polar cases.\(^{11}\) Therefore, we assume now that individuals either do not exhibit any transparency aversion at all or they are sufficiently transparency averse to violate Inequality (7) or Inequality (8), respectively, i.e. \(\psi_j \in \{0, \tilde{\psi}_\tau\}\) with \(\tau = L, M\); \(V_{L,\tilde{\psi}_M}(T_L) < V_L(M)\) and \(V_{L,\tilde{\psi}_L}(T_L) < V_L(L)\).\(^{12}\)

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\(^{11}\)Allowing for a continuous range of transparency aversion results in value functions that do not only differ among the two risk types but among all individuals. Our approach in this context is similar to the approach taken by Filipova et al. (2005).

\(^{12}\)We assume here that consumers do not know the transparency aversion among fellow consumers and therefore can only make their buying decision by comparing their utility of the transparency contract with their utility of the separating or pooling contract based on the initial pool of risks. If consumers could anticipate the transparency aversion of other consumers or if we considered a multi-period framework, in which consumers can compare their utility of a transparency contract with the utility of a new separating or pooling contract based on a new pool of
Hence, transparency averse individuals choose to not reveal their private information, since the disutility resulting therefrom outweighs the utility gain from full insurance coverage, while individuals who do not exhibit transparency aversion choose to reveal their private information and will not suffer any loss of utility therefrom.

**Definition 2:** Let \( k_\tau \in (0,1) \)\(^{13}\) with \( \tau = L, M \) be the fraction of low risks with \( \psi_j = \bar{\psi}_\tau \), respectively. For those consumers the disutility from transparency exceeds the utility gain from a fairly priced contract with full insurance in comparison to the RS separating contract \( L \) and the Wilson pooling contract \( M \), respectively.

**Lemma 2:** The resulting fraction of low risks in the new pool of risks unknown to the insurer is given by:

\[
(1 - \lambda_\tau) := \frac{(1 - \lambda)k_\tau}{(1 - \lambda)k_\tau + \lambda} \quad (9)
\]

Consequently, the fraction of high risks in the new pool is given by:

\[
\lambda_\tau := \frac{\lambda}{(1 - \lambda)k_\tau + \lambda} \quad (10)
\]

**Proof:** See Appendix A.1.2.

In order to investigate how the option to reveal private information before contract inception affects market equilibria, we again have to differentiate the two possible cases of the underlying market composition and the resulting market equilibria without the transparency contract. In other words, we distinguish market equilibria with the transparency option for a market that would result in a separating or a pooling equilibrium, respectively, had there not been the option to reveal consumers’ risk types. In addition to analyzing the resulting market equilibria, we will later on

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\(^{13}\)We neglect the polar cases \( k_\tau \in \{0,1\} \) in our analysis. For \( k_\tau = 1 \), no individual is willing to reveal private information. This case is identical to the case analyzed by Wilson (1977). If \( k_\tau = 0 \), all low risk individuals are willing to share their private information in order to get full insurance at a fair price. This case will therefore lead to a separating equilibrium \((H, T_L)\) as discussed by Browne and Kamiya (2012).
look at how the availability of the contract $T_L = (p^T_L, D)$ affects individuals’ utility depending on their risk type and transparency aversion as well as the implications on overall welfare.

4.3 Persistence of a Separating Equilibrium

**Proposition 1:** Suppose it is $\lambda^{RS} < \lambda$, i.e. without the transparency option there is a self-selecting separating equilibrium $(H, L)$. Then it is $\lambda^{RS} < \lambda \leq \lambda_L$. The separating equilibrium persists. But the non-transparency averse low risks (the ones whose utility from full insurance outweighs the disutility from transparency) choose the conditional contract with full insurance over the contract with partial coverage. Three contracts persist in equilibrium: $(H, L, T_L)$.

**Proof:** The proof follows immediately from Lemma 1 that implies $\lambda \leq \lambda_L$ and from the definition of $\lambda^{RS}$.

![Figure 1: Persistence of a Separating Equilibrium](image)

Figure 1 illustrates the case in which a separating equilibrium exists, i.e. $\lambda^{RS} < \lambda$. The indi-
individuals’ wealth state in case of no loss $w_1$ is represented by the x-axis, whereas the wealth state in case of a loss is displayed on the y-axis. Any pooling contract $M = (q_M, p_M)$ on the insurers’ zero profit line $w_2^M$ offers less utility to low risks than contract $L$, since $w_2^M$ runs entirely below the low risks’ indifference curve $U_L$. The fraction of high risks in the market is already sufficiently high for a separating equilibrium $(H, L)$ to exist. Since the existence of the transparency contract can only increase the fraction of high risks in the pool of unidentified risks, the insurer’s zero profit line for a pooling contract shifts downwards when it is based on the new pool of unidentified risks ($w_2^M'$). The new market equilibrium is described by three contracts, namely the transparency contract $T_L$ and the two contracts $H$ and $L$ that persist in equilibrium and separate the high risks from low risks with high transparency aversion.

4.4 Evolution of a Pooling Equilibrium

Suppose now, it is $\lambda < \lambda^{RS}$, i.e. without telemonitoring there is a pooling equilibrium $(M)$. Then the availability of the transparency contract can cause two possible scenarios depending on the fraction of transparency averse individuals in the market:

**Proposition 2:** If the number of individuals that do not wish to share their private information is sufficiently high, so that it is $\lambda \leq \lambda_M < \lambda^{RS}$, the market equilibrium $(M', T_L)$ is described by a pooling contract and a contract offering the transparency option. The new pooling price is given by $p_M' = \left[\frac{\lambda}{(1-\lambda)} k_M + \lambda (\pi_H - \pi_L) - \pi_L\right] q_M'$.

**Proof:** See Appendix A.1.3.
Figure 2: Persistence of a Pooling Equilibrium

The persistence of the pooling Equilibrium is illustrated in Figure 2. It shows that the insurers’ zero profit line for a pooling contract shifts downwards (from $w^M_2$ to $w^{M'}_2$) due to a higher fraction of high risks in the market. Since there is still a sufficient fraction of low risks in the market for the zero profit line to not shift below the low risks’ indifference curve $U_L$ entirely, a pooling contract can still attract the transparency averse low-risk individuals and therefore a new pooling equilibrium ($M'$) establishes. However, in the new pool of unidentified risks, a higher premium is associated with any given level of coverage and lower coverage is granted with any given premium.

Proposition 3: If the number of individuals that do not wish to share their private information is sufficiently low, so that it is $\lambda < \lambda^{RS} < \lambda_M$, the market equilibrium is described by a three contract separating equilibrium $(H, L, T_L)$.

Proof: The existence of the separating equilibrium $(H, L, T_L)$ follows from Rothschild and Stiglitz (1976) and the definition of $\lambda^{RS}$. \qed
Figure 3 shows a market composition that results in a pooling equilibrium if no transparency contract is offered and establishes a separating equilibrium if consumers can choose to purchase fairly priced insurance conditional on the revelation of private information. The insurers’ zero profit line that pools all unidentified risks shifts below the low risks’ indifference curve when the transparency contract is introduced into the market. A pooling contract cannot attract low-risk individuals anymore and the market equilibrium is described by self-selecting separating contracts.

5 Welfare Analyses

5.1 Changes in Consumers’ Utility for the Respective Market Equilibria

For each of the respective scenarios analyzed in Section 4, we look at how the availability of a transparency contract changes consumers’ utility for the respective consumer groups (high risks, transparency averse low risks, and non-transparency averse low risks) as well as utilitarian welfare.
Proposition 4: Suppose $\lambda^{RS} < \lambda \leq \lambda_L$, i.e. a separating equilibrium with $(H, L)$ exists without telemonitoring and a separating equilibrium $(H, L, T_L)$ exists with telemonitoring, adding a third contract to the market that allows low risks with low transparency aversion to be priced fairly. Further assume that Inequality 7 holds for a fraction of $(1 - \lambda)(1 - k_L)$. Then telemonitoring leads to a Pareto improvement of welfare with a welfare increase of

$$\Delta V = V(H, L, T_L) - V(H, L)$$

$$(1 - \lambda)(1 - k_L)[u(w_0 - \pi_L D) - ((1 - \pi_L) \cdot u(w_0 - \pi_L q_L) + \pi_L \cdot u(w_0 - \pi_L q_L + q_L - D))] > 0$$

Proof: See Appendix A.2.1.

Since the high-risk individuals and the low-risk individuals with high transparency aversion choose the same separating contract as in a situation without the transparency option, their utility does not change with the introduction of a contract that requires transparency and offers full insurance at a fair price. The welfare gain equals the aggregate utility gain of non-transparency averse low risks who receive full insurance at a fair price rather than partial coverage. Since in this setting, individuals who choose the insurance contract with transparency do not exhibit any costs therefrom, this result is in line with Crocker and Snow (1986) who find that market equilibria with costless categorization are potentially Pareto superior to market equilibria without.

Example 1: To illustrate the effects that the introduction of the transparency contract has on market equilibria and social welfare, we choose exemplary values for the individuals’ utility function, their loss probability, their initial wealth and the loss they face: $u(w) = \ln(w)$, $\pi_H = 0.7$, $\pi_L = 0.4$, $w_0 = 10$, $D = 9$. For those values, the pivotal fraction of high risks is given by $\lambda^{RS} \approx 0.44$. We choose $\lambda = 0.6 (> 0.44 = \lambda^{RS})$ and $k = 0.7$, hence $\lambda_L \approx 0.68 (> 0.44 = \lambda^{RS})$, to illustrate the persistence of the separating equilibrium. As there is no change in high risks’ utility and transparency averse low risks’ utility, when they are offered the self selecting contracts, the wel-

\[\lambda^{RS}\] is implicitly defined by $V_L(L) = V_L(M) \iff (1 - \pi_L) \cdot u(w_0 - \pi_L q_L) + \pi_L \cdot u(w_0 - \pi_L q_L + q_L - D) = (1 - \pi_L) \cdot u(w_0 - \lambda^{RS}(\pi_L - q_M - \pi_L q_M) + \pi_L \cdot u(w_0 - \lambda^{RS}(\pi_H - \pi_L) q_M - \pi_L q_M + q_M - D)).$

\[\text{This example corresponds to Figure 1.}\]
fare gain in this example equals the aggregate non-transparency averse low risks’ utility change:
\[ \Delta V = (1 - \lambda)(1 - k_L)(V_{L,0}(T_L) - V_L(L)) \approx 0.168. \]

**Proposition 5:** Suppose \( \lambda \leq \lambda_M < \lambda_{RS} \), i.e. a pooling equilibrium \((M)\) exists without the transparency policy and a pooling equilibrium \((M', T_L)\) exists when adding a second contract to the market that allows low risks with low transparency aversion to receive full coverage at a fair premium. Further assume that Inequality 8 holds for a fraction of \((1 - \lambda)(1 - k_M)\), then the availability of the transparency contract leads to a utility shift from high risks and transparency averse low risks to low risks without transparency aversion. It is

\[
\Delta V_H = V_H(M') - V_H(M) < 0, \quad (12)
\]

\[
\Delta V_{L, \Psi M} = V_L(M') - V_L(M) < 0 \quad (13)
\]

and

\[
\Delta V_{L,0} = V_{L,0}(T_L) - V_L(M) > 0. \quad (14)
\]

The overall change in welfare is ambiguous as it is

\[
\Delta V = V(M', T_L) - V(M) \quad (15)
\]

\[
= \lambda \Delta V_H + (1 - \lambda) k_M \Delta V_{L, \Psi M} + (1 - \lambda)(1 - k_M) \Delta V_{L,0}.
\]

The option to reveal private information in this context leads to a welfare gain if the aggregate increase in non-transparency averse low risks’ utility outweighs the aggregate utility loss for high risks and transparency averse low risks, i.e. if it is

\[
\lambda \left[ V_H(M) - V_H(M') \right] + (1 - \lambda) k_M \left[ V_L(M) - V_L(M') \right] < (1 - \lambda)(1 - k_M) \left[ V_{L,0}(T_L) - V_L(M) \right]. \quad (16)
\]

**Proof:** See Appendix A.2.2.

**Example 2:** To illustrate the persistence of a pooling equilibrium when the conditional insur-
ance contract is introduced to the market, we choose \( \lambda = 0.2 < 0.44 = \lambda^{RS} \) and \( k = 0.7 \), hence \( \lambda_M \approx 0.26 < 0.44 = \lambda^{RS} \).\(^{17}\) The introduction of a transparency contract in a market with this exemplary composition leads to a change in utility for a high-risk individual of

\[
\Delta V_H = V_H(M') - V_H(M)^{18} \approx -0.0471. \tag{17}
\]

Transparency averse low risks’ utility changes by

\[
\Delta V_{L,\psi_M} = V_L(M') - V_L(M) \approx -0.0242 \tag{18}
\]

and non-transparency averse low risks’ experience a utility gain of

\[
\Delta V_{L,0} = V_{L,0}(T_L) - V_L(M) \approx 0.0808. \tag{19}
\]

The overall change in utility is given by

\[
\Delta V = \lambda \Delta V_H + (1 - \lambda)k_M \Delta V_{L,\psi_M} + (1 - \lambda)(1 - k_M) \Delta V_{L,0}
\]

\[
\approx -0.0036.
\]

**Proposition 6:** Suppose \( \lambda < \lambda^{RS} < \lambda_M \), i.e. a pooling equilibrium \((M)\) exists without transparency and a separating equilibrium \((H, L, T_L)\) exists, when adding a contract to the market that allows low risks with low transparency aversion to be priced fairly and receive full coverage. Further assume that Inequality 8 holds for a fraction of \((1 - \lambda)(1 - k_M)\). Then the change in consumers’ utility for the respective group is given by

\[
\Delta V_H = V_H(H) - V_H(M) < 0, \tag{21}
\]

\[
\Delta V_{L,\psi_M} = V_L(L) - V_L(M) < 0 \tag{22}
\]

\(^{17}\)This example corresponds with Figure 2.

\(^{18}\)The optimal coverage for the pooling contract \(M\) is determined by maximizing the low risks’ utility of this contract \(V_L(M)\). The optimal coverage \(q_M'\) for the pooling contract \(M'\) can be found analogously.
The overall change in welfare is ambiguous and depends among other factors on the fraction of high risks, low risks with transparency aversion, and low risks without transparency aversion in the market, as it is

\[
\Delta V = V(H, L, T_L) - V(M) \\
\lambda \Delta V_H + (1 - \lambda) k_M \Delta V_{L,\omega_M} + (1 - \lambda) (1 - k_M) \Delta V_{L,0}. 
\]

The option to reveal private information in this context leads to a welfare gain if the aggregate increase in non-transparency averse low risks’ utility outweighs the aggregate utility loss for high risks and transparency averse low risks, i.e. if it is

\[
\lambda [V_H(M) - V_H(H)] + (1 - \lambda) k_M [V_L(M) - V_L(L)] < (1 - \lambda) (1 - k_M) [V_{L,0}(T_L) - V_L(M)].
\]

**Proof:** See Appendix A.2.3.

**Example 3:** To illustrate the case that the market equilibrium is described by a pooling contract if no transparency policy is available and a separating equilibrium establishes with the introduction of the transparency contract in the market, we choose \( \lambda = 0.2 (< 0.44 = \lambda^{RS}) \) and \( k = 0.3 \), hence \( \lambda_M \approx 0.4545 (> 0.44 = \lambda^{RS}) \).

The introduction of a transparency contract in a market with this exemplary composition leads to a change in utility for a high-risk individual of

\[
\Delta V_H = V_H(H) - V_H(M) \approx -0.3936.
\]

Transparency averse low risks’ utility changes by

\[
\Delta V_{L,\omega_M} = V_L(L) - V_L(M) \approx -0.0871
\]
and non-transparency averse low risks’ experience a utility gain of

$$
\Delta V_{L,0} = V_{L,0}(T) - V_{L}(M) \approx 0.0808. \tag{28}
$$

The overall change in utility is given by

$$
\Delta V = \lambda \Delta V_H + (1 - \lambda)k_M \Delta V_{L,\bar{\psi}_M} + (1 - \lambda)(1 - k_M)\Delta V_{L,0}
\approx -0.0544. \tag{29}
$$

### 5.2 Illustration of Changes in Consumers’ Utility

In the following, we illustrate how the underlying market composition affects the utility of different consumer types when offering a transparency contract. The heat diagrams show the fraction of high-risk individuals in the market on the x-axis and the fraction of transparency averse individuals among low risks on the y-axis. The utility change for the respective consumer group is displayed by different shades of gray with the respective values measured by the bar to the right of each diagram. We again choose exemplary values for the individuals’ utility function, their loss probability, their initial wealth and the loss they face: $u(w) = \ln(w)$, $\pi_H = 0.7$, $\pi_L = 0.4$, $w_0 = 10$, $D = 9$ as in the examples before.
For any values $\lambda < \lambda^{RS} \approx 0.44$, the insurance market equilibrium is described by a pooling contract if there is no transparency contract offered. Figure 4 shows that the utility change for high risks in this case heavily depends on how the market composition changes with the introduction of such a contract. If the fraction of transparency averse low risks is sufficiently high for the new market equilibrium to still be described by a pooling contract (as shown in the white and light gray shaded area on the left of the diagram), the loss in utility for high risks is lower than if a separating equilibrium establishes with the introduction of the transparency contract (as shown in the darker gray and black shaded area). High risks face the highest loss of utility, when their share in the market is very low but the introduction of the transparency contract still leads to a separating equilibrium due to a very low fraction of transparency averse low risks. This is due to the fact that with very few high risks in the market, the initial pooling price is very low, and therefore the reference level of utility in the absence of a transparency contract is high.
Figure 5 shows the change in transparency averse low risks’ utility due to the introduction of a transparency contract. Given that the market equilibrium is described by a pooling contract in the absence of the transparency policy, the change in transparency averse low risks’ utility follows roughly the same pattern than the change in high risks’ utility. However, in comparison with the high risks’ change in utility, the utility loss that transparency averse low risks face, if the introduction of the transparency contract leads to a separating equilibrium, is lower relative to the utility loss they face if a pooling equilibrium is established.

Although nothing changes in their probability of loss, low-risk individuals who value their privacy sufficiently high to not be willing to share private information, face a potential loss of utility by the introduction of the transparency contract to the market.

The rectangle on the right side of each, Figure 4 and Figure 5, shows that neither high-risk individuals nor transparency averse low-risk individuals face any change in utility if the market composition leads to a separating equilibrium in the absence of a transparency contract, i.e. for $\lambda \geq \lambda^{RS} \approx 0.44$. 
The obvious winners from the availability of the transparency contract are those consumers who have a low probability of loss and do not face any disutility from revealing their private information. Their utility gain increases with the fraction of high risks in the market, as the reference level of utility in case of the non-existence of the transparency contract decreases with the fraction of high-risk individuals. Their utility gain is highest when the market equilibrium is described by two self-selecting separating contracts in the absence of the transparency policy.
The impact the availability of a transparency contract has on utilitarian social welfare is ambiguous and depends on the composition of individuals in the market, with respect to their risk type and transparency aversion. Figure 7 illustrates the Pareto improvement resulting from the persistence of a separating equilibrium with the white and light gray shaded area on the right of the heat diagram. The highest welfare gain resulting from the introduction of a transparency contract is reached when there are just enough high-risk individuals in the market for a separating equilibrium to exist in the absence of the transparency contract, and very few low-risk individuals exhibit a transparency aversion, i.e. the number of individuals who benefit from the introduction of a transparency contract is very high. This case is represented by the white shaded area. If a pooling equilibrium exists in the absence of a transparency contract, the aggregate utility loss of high risks and of transparency averse low-risk individuals outweighs the aggregate utility gain of non-transparency averse low risks in our example. Since overall welfare is the weighted aggregate utility of all consumers, the welfare loss is highest where the fraction of high risks is highest within the situation, where the introduction of the transparency contract causes a change from pooling to
separating equilibrium, as it is illustrated by the black shaded area in the heat diagram.

6 Conclusion and Outlook

Screening consumers’ characteristics can mitigate problems arising from information asymmetries that lead to adverse selection in insurance markets. Nowadays, telemonitoring devices, such as wearables in health insurance or a telematics system in car insurance, can be used to price the insurance policyholders’ risk more accurately. However, some individuals value their privacy and don’t feel comfortable sharing information with insurers. They exhibit a disutility from being transparent consumers. The degree of this transparency aversion might differ among consumers but does not necessarily depend on whether consumers are ”low risks” or ”high risks”. The disutility a consumer might face when revealing private information might outweigh the utility increase from a potential premium reduction or higher coverage.

In our analysis, we consider an insurance market with asymmetric information consisting of risk neutral, nonmyopic insurers that operate in a competitive market environment and risk averse consumers who differ in their risk type and transparency aversion. In a theoretical model, we introduce the possibility for consumers to reveal their risk type for a certain subjective cost in exchange for a premium adjustment. We show analytically how this possibility affects the standard results regarding insurance market equilibria in the Wilson (1977) framework and the respective effects on consumers’ individual utility and social welfare, given that a certain fraction of consumers exhibits transparency aversion.

The Wilsonian standard insurance market equilibrium outcomes depend on the fraction of high-risk individuals. If this fraction exceeds a critical value, a pooling contract priced at the average risk does not attract low-risk consumers and therefore the market equilibrium is described by two self-selecting separating contracts. Since the transparency contract only attracts low-risk individuals, the fraction of high-risk individuals in the pool of unidentified consumers can only increase due to the availability of such a policy. As a result, the availability of a transparency contract does not break up an existing separating equilibrium. If a pooling equilibrium exists in the absence of the transparency contract, the market equilibrium resulting from the introduction of a transparency contract depends on the fraction of transparency averse low risks. The impact the availability of
a transparency contract has on social welfare is ambiguous and depends on the underlying market equilibrium without the transparency contract and therefore on the composition of individuals in the market, with respect to their risk type and transparency aversion.

Our analysis shows that the choice of information disclosure with respect to revelation of their risk type can serve as a substitute to a deductible for consumers, whose aversion to share private information is sufficiently low. This can lead to a Pareto improvement of social welfare. However, if all consumers are offered the same insurance contract that is priced at the average risk, low-risk individuals who exhibit a transparency aversion and high-risk individuals can be worse off due to the availability of a transparency policy. In this case, utility is shifted from individuals who choose not to reveal their private information to those who choose to reveal, and the change in social welfare is ambiguous. The welfare loss is highest where the initial fraction of high risks in the market is just falling short of the pivotal fraction, and the share of transparency averse low-risk individuals is relatively high. This situation corresponds to an initial pooling equilibrium that is turned into a separating equilibrium by introducing the transparency contract. While the first intuition might be that the digital development in insurance might not affect consumers who are not willing to participate, our analysis shows that each insurance policy’s characteristics depend on other consumers’ valuation of private information when monitoring is possible.

An interesting modification of our model could analyze in how far our results may alter when tele-monitoring is costly, whereas the costs could either be borne by the policyholders using it, or the costs could be distributed among all policyholders as a premium loading.

Further research could abstract from the discrete standard models in the area of asymmetric information and look at the effects a continuous level of transparency, as well as a continuous distribution of transparency aversion has on the insurance market. Alternative frameworks might also help to understand how the effects alter in different regulatory environments: One can for instance think of a case where transparency becomes a conditional requirement for the insurance contract to come into effect, for instance if automobile producers pre-install monitoring devices in all vehicles. When full transparency is enforced, information is symmetric and the insurer can price individuals according to their respective accident probabilities. This setting raises the question whether high-risk individuals are still insurable when they have to reveal their risk type. Further, in this case, there can be two possible scenarios: (1) If it is possible to not purchase insurance at all, e.g. by not buying
a car, individuals with high transparency aversion will choose to do so, and the market composition of risks depends on the correlation between the accident probability and transparency aversion. (2) If the individual has to be insured, the enforced transparency leads to a substantial welfare loss resulting from the disutility policyholders obtain by sharing private information. In order to draw implications for the insurance industry, empirical research is needed on how transparency aversion is distributed in the population.

References


A Appendix

A.1 Proofs Equilibrium Analysis

A.1.1 Proof of Lemma 1:

(i): If $\lambda \geq \lambda^{RS}$:

For high-risk individuals in order to prefer the transparency contract over a RS-separating contract, it has to hold:

\[
V_{H,\psi_j}(T_H) > V_H(H) \quad (30)
\]
\[
u(w_0 - \pi_H D) - \psi_j > u(w_0 - \pi_H D)
\]
\[
\psi_j < 0
\]

This is violated by assumption. \hfill \Box

(ii): If $\lambda < \lambda^{RS}$:

The proof for Lemma 1 (ii) is not done, yet.

A.1.2 Proof of Lemma 2:

Given Definition 2, the fraction of individuals with $\psi_j = 0$, that reveal their information by choosing the telemonitoring contract and hence leave the pool of risks the insurer cannot identify is given by $(1-\lambda)(1-k_\tau)$. Therefore, the fraction of consumers who do not wish to reveal their information and therefore build a new pool of risks unknown to the insurer is described by $(1-\lambda)k_\tau + \lambda$. \hfill \Box
A.1.3 Proof of Proposition 2:

The existence of the pooling equilibrium \((M', T)\) follows from Wilson \((1977)\) and the definition of \(\lambda^{RS}\). The equilibrium price is given by:

\[
p_{M'} = [\lambda_M \pi_H + (1 - \lambda_M) \pi_L] q_{M'}
\]

\[
= [\lambda_M (\pi_H - \pi_L) + \pi_L] q_{M'}
\]

\[
= \left[\frac{\lambda}{(1 - \lambda)k_M + \lambda(\pi_H - \pi_L) + \pi_L} \right] q_{M'}
\]

A.2 Proofs Welfare Analysis

A.2.1 Proof of Proposition 4:

Low risks’ utility of separating contract without transparency:

\[
V_L(L) = (1 - \pi_L) \cdot u(w_0 - p_L) + \pi_L \cdot u(w_0 - p_L + q_L - D)
\]

\[
= (1 - \pi_L) \cdot u(w_0 - \pi_L q_L) + \pi_L \cdot u(w_0 - \pi_L q_L + q_L - D)
\]

High risks’ utility of separating contract without transparency:

\[
V_H(H) = u(w_0 - p_H)
\]

\[
= u(w_0 - \pi_H D)
\]

Low risks’ utility of a transparency contract:

\[
V_{L,0}(T_L) = u(w_0 - \pi_L D)
\]
Utility changes resulting from introduction of the transparency contract:

Change in utility for high risk individuals:

\[ \Delta V_H = V_H(H) - V_H(H) = 0 \] (35)

Change in utility for transparency averse low risk individuals:

\[ \Delta V_{L,\bar{\psi}_L} = V_L(L) - V_L(L) = 0 \] (36)

Change in utility for non-transparency averse low risk individuals:

\[
\begin{align*}
\Delta V_{L,0} &= V_{L,0}(T_L) - V_L(L) \\
&= u(w_0 - \pi_L D) - [(1 - \pi_L)u(w_0 - \pi_L q_L) + \pi_L u(w_0 - \pi_L q_L + q_L - D)] \\
&> 0
\end{align*}
\] (37)

Overall consumers’ utility without a transparency contract in a separating equilibrium:

\[ V(H, L) = \lambda V_H(H) + (1 - \lambda)V_L(L) \] (38)

Overall consumers’ utility with a transparency contract in a separating equilibrium:

\[ V(H, L, T_L) = \lambda V_H(H) + (1 - \lambda)k_L V_L(L) + (1 - \lambda)(1 - k_L)V_{L,0}(T_L) \] (39)

\[
\begin{align*}
\Delta V &= V(H, L, T_L) - V(H, L) \\
&= \lambda \Delta V_H + (1 - \lambda)k_L \Delta V_{L,\bar{\psi}_L} + (1 - \lambda)(1 - k_L) \Delta V_{L,0} \\
&= (1 - \lambda)(1 - k_L) * [u(w_0 - \pi_L D) - [(1 - \pi_L)u(w_0 - \pi_L q_L) + \pi_L u(w_0 - \pi_L q_L + q_L - D)]] \\
&> 0
\end{align*}
\] (40)
A.2.2 Proof of Proposition 5:

To show:

(i) $\Delta V_H = V_H(M') - V_H(M) < 0$,  \hspace{1cm} (41)

(ii) $\Delta V_{L,\tilde{\varphi}_M} = V_L(M') - V_L(M) < 0$  \hspace{1cm} (42)

(iii) $\Delta V_{L,0} = V_{L,0}(T_L) - V_L(M) > 0$  \hspace{1cm} (43)

(iv) $V(M', T_L) - V(M) > 0$  \hspace{1cm} (44)

$\iff \frac{\lambda}{1 - \lambda} < \frac{(1 - k_M)V_{L,0}(T_L) + k_MV_L(M') - V_L(M)}{V_H(M) - V_H(M')}$

(i): The proof for Proposition 5 (i) is not done, yet.

(ii): For every given coverage $q$, the premium $p(q)$ is lower for the contract $M$ than it is for the contract $M'$: Therefore, the maximum of the expected low risks’ utility of contract $M$ is higher than the maximum of the expected low risks’ utility of contract $M'$. The respective coverage $q_M$ and $q_{M'}$ in both contract is chosen as to maximize low risks’ expected utility. It follows that $V_L(M') < V_L(M)$.

(iii): The change in utility for non transparency averse low risk individuals is given by:

$$\Delta V_{L,0} = V_{L,0}(T_L) - V_L(M)$$

$$\Delta V_{L,0} = u(w_0 - \pi_L D) - [\pi_L * u(w_0 - p_M + q_M - D) + (1 - \pi_L)u(w_0 - p_M)]$$

$$\Delta V_{L,0} = u(w_0 - \pi_L D) - [\pi_L * u(w_0 - [\lambda \pi_H + (1 - \lambda)\pi_L]q_M + q_M - D) + (1 - \pi_L)u(w_0 - [\lambda \pi_H + (1 - \lambda)\pi_L]q_M)]$$

$\Delta V_{L,0} > 0$
(iv): The change in overall welfare is given by:

\[ \Delta V = V(M', T_L) - V(M) \]

\[ = \lambda \Delta V_H + (1 - \lambda) k_M \Delta V_{L,\bar{\psi}_M} + (1 - \lambda)(1 - k_M) \Delta V_{L,0} \]

\[ = \lambda \Delta (V_H(M') - V_H(M)) + (1 - \lambda) k_M (V_L(M') - V_L(M)) + (1 - \lambda)(1 - k_M)(V_{L,0}(T_L) - V_L(M)) \]

The option to reveal private information in this context leads to a welfare gain iff

\[ 0 < \Delta V \] (47)

\[ \iff 0 < \lambda (V_H(M') - V_H(M)) + (1 - \lambda) k_M (V_L(M') - V_L(M)) + (1 - \lambda)(1 - k_M)(V_{L,0}(T_L) - V_L(M)) \]

\[ \iff \frac{\lambda}{1 - \lambda} < \frac{(1 - k_M)V_{L,0}(T_L) + k_M V_L(M') - V_L(M)}{V_H(M) - V_H(M')} \]

\[ \square \]

A.2.3 Proof of Proposition 6:

To show:

(i) \[ \Delta V_H = V_H(H) - V_H(M) < 0, \] (48)

(ii) \[ V_{L,\bar{\psi}_M} = V_L(L) - V_L(M) < 0, \] (49)

(iii) \[ V_{L,0} = V_{L,0}(T_L) - V_L(M) > 0, \] (50)

(iv) \[ V(H, L, T_L) - V(M) > 0 \]

\[ \iff \frac{\lambda}{1 - \lambda} < \frac{(1 - k_M)V_{L,0}(T_L) + k_M V_L(L) - V_L(M)}{V_M(M) - V_H(H)} \] (51)

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(i): It follows analogously to part (ii) of the proof of Lemma 1 in Appendix A.1.1.

(ii) holds by the assumption \( \lambda < \lambda_{RS} \), i.e. for \( \lambda < \lambda_{RS} \) low risks' utility from a separating contract is lower than their utility from a pooling contract (with respect to the initial pool of risks without the availability of a transparency contract).

(iii): The change in utility for non transparency averse low risk individuals is given by:

\[
\Delta V_{L,0} = V_{L,0}(T_L) - V_L(M) \\
= u(w_0 - \pi_L D) - [\pi_L * u(w_0 - p_M + q_M - D) + (1 - \pi_L)u(w_0 - p_M)] \\
= u(w_0 - \pi_L D) \\
- [\pi_L * u(w_0 - [\lambda \pi_H + (1 - \lambda)\pi_L]q_M + q_M - D) + (1 - \pi_L)u(w_0 - [\lambda \pi_H + (1 - \lambda)\pi_L]q_M)] \\
> 0
\]

(iv): The change in overall welfare is given by:

\[
\Delta V = V(H, L, T_L) - V(M) \\
= \lambda \Delta V_H + (1 - \lambda)k_M \Delta V_{L,0} + (1 - \lambda)(1 - k_M)\Delta V_{L,0} \\
= \lambda \Delta(V_H(H) - V_H(M)) + (1 - \lambda)k_M(V_L(L) - V_L(M)) + (1 - \lambda)(1 - k_M)(V_{L,0}(T_L) - V_L(M))
\]

The option to reveal private information in this context leads to a welfare gain iff

\[
0 < \Delta V \\
\Leftrightarrow 0 < \lambda(V_H(H) - V_H(M)) + (1 - \lambda)k_M(V_L(L) - V_L(M)) + (1 - \lambda)(1 - k_M)(V_{L,0}(T_L) - V_L(M)) \\
\Leftrightarrow \frac{\lambda}{1 - \lambda} < \frac{(1 - k_M)V_{L,0}(T_L) + k_M V_L(L) - V_L(M)}{V_M(M) - V_H(H)}
\]

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A.3 Exemplary Calculations Welfare Analysis

A.3.1 Example 1

For the calculation of low-risk individuals’ utility from a separating contract \( L \), we need to derive the optimal coverage for a contract that does not attract high risks. The optimal coverage can be determined by the following maximization problem:

\[
\max_{q_L} (1 - \pi_L) \cdot u(w_0 - p_L) + \pi_L \cdot u(w_0 - p_L + q_L - D) \quad (55)
\]

s.t.

\[
(1 - \pi_H) \cdot u(w_0 - p_L) \leq u(w_0 - p_L) + \pi_H \cdot u(w_0 - p_L + q_L - D)
\]

\[
p_H = \pi_H D
\]

\[
p_L = \pi_L q_L
\]

\[
q_L \leq D \leq w_0
\]

\[
0 < \pi_L < \pi_H < 1
\]

\[
0 < \lambda < 1
\]

We use an alternative approach oriented at the graphical illustration: From Rothschild and Stiglitz (1976), we know that the fair odd lines are of the following form

\[
E_i = -\frac{1 - \pi_i}{\pi_i} w_1 + n \quad (56)
\]

with \( i \in \{H, L\} \).
The position of the fair odd lines are derived as follows

\[
\begin{align*}
\frac{w_0 - D}{\pi_i} &= -\frac{1}{\pi_i} w_0 + n \\
n &= \frac{1}{\pi_i} w_0 + w_0 - D \\
n &= \left(1 - \frac{1}{\pi_i} + \frac{\pi_i}{\pi_i}\right) w_0 - D \\
n &= \frac{1}{\pi_i} w_0 - D
\end{align*}
\]  

(57)

Therefore, the low risks’ fair odd line is given by:

\[
EL = -\frac{1}{\pi_L} w_1 + \frac{1}{\pi_L} w_0 - D
\]  

(58)

Analogously, the high risks’ fair odd line is given by:

\[
EH = -\frac{1}{\pi_H} w_1 + \frac{1}{\pi_H} w_0 - D
\]  

(59)

In order to derive the high risks’ indifferent curve, we first solve their utility by the wealth state in case of an accident \(w_2\).

\[
\begin{align*}
V_H &= (1 - \pi_H)u(w_1) + \pi_H u(w_2) \\
u(w_2) &= \frac{V_H - (1 - \pi_H)u(w_1)}{\pi_H} \\
w_2(w_1) &= u^{-1}\left(\frac{V_H - (1 - \pi_H)u(w_1)}{\pi_H}\right)
\end{align*}
\]  

(60)

The level of high risks’ utility at full insurance for a fair premium is given at:

\[
V_H(D) = u(w_0 - \pi_H D)
\]  

(61)

In order to derive the indifference curve for high risks at the utility level of the full insurance...
contract, we plug this utility level into \( w_2(w_1) \):

\[
w_2(w_1, V_H(D)) = u^{-1}\left( \frac{u(w_0 - \pi_H D) - (1 - \pi_H) u(w_1)}{\pi_H} \right)
\]

Since the optimal contract for low risks has to make high risks indifferent to their fair contract with full insurance while still letting the insurer break even, the optimal \( q_L \) is found at the intersection of the high risks’ indifference curve \( w_2(w_1, V_H(D)) \) and the low risks’ fair odd line \( EL \).\(^{20}\) Therefore, the optimal contract for low risks is implicitly defined by the following condition:

\[
\frac{w_2(w_1, V_H(D))}{\pi_H} = EL
\]

For \( u(\cdot) = \ln(\cdot) \), we get

\[
w_2(w_1, V_H(D)) = \exp\left( \frac{\ln(w_0 - \pi_H D) - (1 - \pi_H) \ln(w_1)}{\pi_H} \right)
\]

and therefore the optimal level of wealth in the no accident state for the low risk contract in a separating equilibrium is implicitly given by

\[
\exp\left( \frac{\ln(w_0 - \pi_H D) - (1 - \pi_H) \ln(w_1)}{\pi_H} \right) = \frac{1 - \pi_L}{\pi_L} w_1 + \frac{1}{\pi_L} w_0 - D
\]

With \( \pi_H = 0.7, \pi_L = 0.4, w_0 = 10, \text{ and } D = 9 \), we get \( w_1 \approx 8.9798 \) and therefore \( q_L = 2.5505 \).

\(^{20}\)Compare Rothschild and Stiglitz (1976).