# Hidden Regret in Insurance Markets*

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**Abstract**

We examine insurance markets with two-dimensional asymmetric information on risk type and on preferences related to regret. In contrast to Rothschild and Stiglitz (1976), the equilibrium can be efficient, i.e., it can coincide with the equilibrium under full information. Furthermore, we show that pooling, semi-pooling, and separating equilibria can exist. Specifically, there exist separating equilibria that predict a positive correlation between the level of insurance coverage and risk type, as in the standard economic models of adverse selection, but there also exist separating equilibria that predict a negative correlation between the level of insurance coverage and risk type. Since optimal choice of regretful customers depends on foregone alternatives, the equilibrium includes a contract which is offered but not purchased.

**Key Words** asymmetric information, regret, insurance

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# 1 Introduction

Regret theory was initially developed by Bell (1982) and Loomes and Sugden (1982) and has been shown in both the theoretical and experimental literature to be an important factor in explaining individual behavior. The impact of regret on decision making has been examined in different economic settings. Braun and Muermann (2004) and Muermann et al. (2006) show that anticipatory regret moves individuals away from extreme decisions. Compared to preferences that satisfy the axioms of von Neumann and Morgenstern, regret leads individuals to purchase more (less) insurance coverage if insurance is relatively expensive (cheap) and, analogously, anticipatory regret implies that financial investors invest more (less) in risky stocks if the equity risk premium is relatively high (low). In a dynamic setting, Muermann and Volkman (2006) show that anticipatory regret and pride can cause investors to sell winning stocks and hold on to losing stocks, i.e., it might help explain behavior that is consistent with the disposition effect. Regret preferences have also been applied to asset pricing and portfolio choice in an Arrow-Debreu economy (Gollier and Salanié, 2006), to first price auctions (Filiz-Ozbay and Ozbay, 2007), and to currency hedging (Michenaud and Solnik, 2008).[1]

This paper contributes to the literature by examining the equilibrium effects of anticipatory regret under asymmetric information. We consider a perfectly competitive insurance market with policyholders that are heterogeneous with respect to both risk type and regret preferences. In particular, there are individuals who account for anticipated regret in their decision-making, and there are individuals whose decision-making is not influenced by anticipatory regret.

Rothschild and Stiglitz (1976) show in their classical adverse selection model in insurance mar-

[1] There is much empirical evidence of both individuals experiencing regret and the anticipation of regret influencing individual decision making (see, e.g., Loomes, 1988; Loomes et al., 1992; Simonson, 1992; Larrick and Boles, 1995; Ritov, 1996). We refer to Zeelenberg (1999) who reviews the evidence from these and other studies in which regret is made salient to individuals at the time of choice and from studies in which the uncertainty resolution of alternative choices is manipulated. More recently, Zeelenberg and Pieters (2004) compare two lotteries in the Netherlands, a regular state lottery and a postcode lottery in which the postcode is the ticket number. In the latter lottery, individuals who decide not to play the lottery thus receive feedback about whether they would have won had they played the lottery. They conduct different studies which all confirm that this feedback causes regret and changes the decision whether to play the lottery. Filiz-Ozbay and Ozbay (2007) conduct first price auction experiments and show that individuals experience loser regret - the regret a losing bidder experiences if the winning bid is revealed - which leads them to overbid. Finally, Camille et al. (2004) and Coricelli et al. (2005) find that the medial orbitofrontal cortex plays a central role in mediating the feeling of regret. In the experimental study of Camille et al. (2004) normal subjects reacted to the experience of regret and chose to minimize it in the future while patients with orbitofrontal cortex lesions did not report regret or anticipated negative consequences from their choices. Using functional magnetic resonance imaging (fMRI), Coricelli et al. (2005) found enhanced activity in the medial orbitofrontal cortex in response to an increase in regret.

kets that in equilibrium–if it exists–lower risk individuals self-select into contracts which offer lower insurance coverage. Recently, the insurance literature has extended the model of Rothschild and Stiglitz (1976) in two directions, inspired by the mixed empirical evidence regarding the residual correlation between risk type and insurance coverage.[2] The first strand of literature examines one-dimensional heterogeneity of customers who engage in potentially different, unobservable actions which imply heterogeneity in risk type. They show that there could exist equilibria in which individuals with certain characteristics both purchase more insurance coverage and invest more in risk-mitigating measures–thereby becoming lower risk types–than other individuals. This negative relationship between insurance coverage and risk type is called advantageous selection.[3]

The second strand of literature considers two-dimensional heterogeneity of customers with respect to risk type and risk aversion (see Smart, 2000, Wambach, 2000, and Villeneuve, 2003). Those models predict, as Rothschild and Stiglitz (1976), a positive correlation between insurance coverage and risk type. Netzer and Scheuer (2010), however, show that by endogenizing heterogeneity in wealth levels and thereby risk aversion negative correlation between insurance coverage and risk type can be obtained. Sandroni and Squintani (2007) argue that individuals might be heterogeneous in risk perception. Some high risk policyholders might be overconfident and mistakenly believe that they are low risk types. They find that compulsory insurance might not improve all agents' welfare.[4]

In this paper, we adopt a two-dimensional approach and analyze the existence and properties

[2] In markets for acute health care insurance and annuities the empirical evidence is consistent with the prediction of adverse selection and moral hazard models (see e.g., Cutler and Zeckhauser, 2000; Mitchell et al., 1999; Finkelstein and Porteba, 2004). In contrast, a negative relationship between insurance coverage and claim frequency exists in markets for term-life insurance and Medigap insurance (see e.g. Cawley and Philipson, 1999; Fang et al., 2008). Last, in automobile insurance and long-term care insurance (see e.g., Chiappori and Salanié, 2000; Finkelstein and McGarry, 2006) the correlation between insurance coverage and claim frequency is not significantly different from zero.

[3] For example, de Meza and Webb (2001) analyze the effect of hidden information on individuals' degree of risk aversion combined with hidden action. Similarly, Jullien et al. (2007) study a principal-agent model in which the agent has private information about his degree of risk aversion. Sonnenholzner and Wambach (2009) examine insurance markets in which customers have private information about their time preferences. They show that a negative correlation between insurance coverage and risk type can emerge in equilibria since impatient customers might both spend less on insurance coverage and risk mitigation, thereby becoming higher risk types. Huang et al. (2010) analyze a setting in which the degree of overconfidence is hidden information and show that, in equilibrium, overconfident types spend less on insurance coverage and risk mitigation.

[4] The empirical evidence, however, on the sign of the negative relationship between degree of risk aversion and risk type is mixed. Finkelstein and McGarry (2006) find evidence in the long-term care insurance market that is consistent with advantageous selection, i.e. more risk averse individuals are more likely to purchase long-term care insurance and less likely to enter a nursing home. In contrast, Cohen and Einav (2007) and Fang, et al. (2008) find the opposite in automobile and Medigap insurance: risk type is positively correlated with risk aversion.

of equilibria. The first dimension is, as in Rothschild and Stiglitz (1976), risk type. Policyholders are either high risk or low risk. The second dimension relates to regret preferences. There are policyholders who regret not having chosen foregone better alternatives and policyholders who do not regret.

Regret is interpreted as the anticipated disutility incurred from an ex-ante choice that turns out to be ex-post suboptimal. Individuals make their decision by trading off the maximization of expected utility of wealth against the minimization of expected disutility from anticipated regret. The latter is modeled as a second attribute to the utility function that depends on the difference in utilities of wealth levels derived from the foregone best alternative and derived from the actual choice.

Anticipatory regret introduces two interesting and novel features in our setting of an insurance market with asymmetric information. First, the relative valuation of insurance coverage between different types of customers depends on the amount of insurance coverage offered. At high levels of insurance coverage, a higher degree of regret aversion implies a lower valuation of insurance coverage, whereas at low levels of insurance coverage, a higher degree of regret aversion implies a higher valuation of insurance coverage. In the existing literature, the relative valuation of insurance coverage is independent of the level of insurance coverage. Higher risk types, more risk averse individuals, or more patient individuals value insurance coverage relative more at any level of insurance coverage. Second, preferences incorporating regret have the feature that individual welfare depends on the set of foregone alternatives. This implies that insurance companies can strategically influence individual choice by offering additional contracts even if they are not purchased.

We find that the efficient, full-information equilibrium can be obtained. We further show that pooling, semi-pooling, and separating equilibria can exist. Specifically, depending on the parameters of the model, there exist separating equilibria that predict a positive correlation between the level of insurance coverage and risk type, as in the standard economic models of adverse selection, but there also exist separating equilibria that predict a negative correlation between the level of insurance coverage and risk type. An interesting empirical prediction relates to the above mentioned characteristic of regret that the optimal choice depends on the set of foregone alternatives. This implies that, in equilibrium, a contract is offered which is not purchased. This contract provides the highest net payment – indemnity net of premium – amongst all contracts offered.

To provide more details about and intuition for our equilibrium results, we first note that under full information and actuarially fair premium rates regret-neutral individuals are fully insured, as in the setting of Rothschild and Stiglitz (1976) under full information, while regret-averse individuals are partially insured. Some reduction in insurance coverage lowers anticipatory regret since the reduction in regret if losses do not realize outweighs the additional regret if losses realize.

Let us start with the separating equilibrium in the setting of Rothschild and Stiglitz (1976): high risk individuals are fully insured while low risk individuals self-select into partial insurance contracts. Both contracts are priced at premium rates that are actuarially fair with respect to each risk type and the correlation between the level of insurance coverage and risk type is positive. First, we change preferences of low risk individuals by introducing regret-aversion. For low levels of regret-aversion, the equilibrium contract under full information for low risk individuals features partial coverage but deviates only minimally from full coverage such that this contract does not satisfy the self-selection constraint under asymmetric information. Thus, low risk individuals are covered at a lower level of coverage at which the self-selection constraint is binding while high risk, regret-neutral individuals are fully covered. The qualitative features of the separating equilibrium in the setting of Rothschild and Stiglitz (1976) are therefore robust to the introduction of low levels of regret aversion for low risk individuals and the correlation between the level of insurance coverage and risk type is positive. Increasing the level of regret aversion for low risk individuals reduces the level of coverage of the equilibrium contract under full information. For high levels of regret aversion, the level of this contract might be low enough to satisfy the self-selection constraint of low risk individuals under asymmetric information. In this case, the equilibrium under full information is obtained and the correlation between insurance coverage and risk is still positive.

Next, let us deviate from the setting of Rothschild and Stiglitz (1976) by adding regret-aversion to the preferences of high risk individuals. For low levels of regret-aversion, the separating equilibrium only changes insofar as high risk, regret-averse individuals are partially covered by the contract that they obtain in equilibrium under full information. Qualitatively, this does not affect the self-selection constraint of low risk individuals. In particular, full coverage at the actuarially fair premium rate for low risks does not satisfy the self-selection constraint. Thus, both risk types are partially covered but the correlation between insurance coverage and risk remains positive. For high levels of regret aversion, however, the coverage of the equilibrium contract for high risk, regret-averse individuals might be so low that the full insurance contract at the actuarially fair premium rate for low risks satisfies the self-selection constraint for low risk, regret-neutral individuals. In this case, the equilibrium coincides with the equilibrium under full information in which low risk individuals are fully insured and high risk, regret-averse individuals are partially insured. The correlation between insurance coverage and risk is then negative.

In the following section, we introduce the model and derive properties of indifference curves as those will be used for our graphical analysis of equilibria in Section 3. Section 4 concludes the paper.

# 2 Model Approach

We examine a competitive insurance market with risk-neutral and regret-neutral insurers. Policyholders have private information regarding their risk type and their preferences towards regret. They can be classified into four groups: high risk types with regret-averse preferences, high risk types with regret-neutral preferences, low risk types with regret-averse preferences, and low risk types with regret-neutral preferences. We consider the two scenarios for which two types of policyholders coexist who differ with respect to both dimensions, risk type and regret preferences.[5] In Scenario I, there are high risk types who are regret-neutral (type $HN$) and low risk types who are regret-averse (type $LR$). In Scenario II, there are high risk types who are regret-averse (type $HR$) and low risk types who are regret-neutral (type $LN$).

## 2.1 Scenario I: types $HN$ and $LR$ individuals

Two types of individuals, types $HN$ and $LR$, exist in the market. Let $\lambda$ be the fraction of type $HN$ individuals in the population. Both types are endowed with initial wealth $w$ and face a potential loss of size $L$. The probability of loss for types $HN$ and $LR$ are respectively $p_H$ and $p_L$, where $p_H > p_L$. Let $(I, c)$ denote an insurance contract with coverage $I$ and premium rate $c$. We exclude

[5] In all other scenarios with two types, policyholders differ with respect to only one dimension, either risk type or regret preferences. If policyholders differ only with respect to risk type, then the equilibrium is similar to that in Rothschild and Stiglitz (1976). If they differ only with respect to regret preferences, then the equilibrium coincides with the equilibrium under full information with regret-neutral policyholders being fully insured and regret-averse policyholders being partially insured at the identical, actuarially fair premium rate. The reason is that regret-averse policyholders prefer partial coverage at actuarially fair rates contrary to regret-neutral policyholders who prefer full coverage (see Braun and Muermann, 2004).

the possibility of overinsurance and taking a short position, i.e., we assume $0 \leq I \leq L$.[6]

The level of expected utility for type $HN$ individuals with insurance contract $(I, c)$ is

$$EU_{HN}(I, c) = p_H u(W_1) + (1 - p_H) u(W_0), \tag{1}$$

where $W_0 = w - cI$ and $W_1 = w - L + (1 - c) I$ are the final wealth levels in the no-loss and in the loss states, respectively.

For regret-averse individuals, we follow Bell (1982) and Loomes and Sugden (1982) by implementing the following two-attribute utility function to incorporate anticipatory regret in preferences

$$v(W, W^{\max}) = u(W) - g(u(W^{\max}) - u(W)). \tag{2}$$

Regret-averse individuals thus maximize expected utility with respect to the utility function $v(\cdot)$.[7] The first attribute is the utility derived from the final level of wealth, $W$, and is thus equivalent to the utility of regret-neutral individuals. The second attribute accounts for the fact that regret-averse individuals consider regret in their decision-making. Regret depends on the difference between the utility of wealth the individual could have obtained from the foregone best alternative (FBA), $W^{\max}$, and the utility of actual final wealth, $W$. The function $g(\cdot)$ measures the disutility incurred from regret and we assume that $g(\cdot)$ is increasing and convex with $g(0) = 0$. This assumption is supported in the literature (Thaler, 1980, Kahneman and Tversky, 1982) and has recently found experimental support by Bleichrodt et al. (2010). Laciana and Weber (2008) show that the convexity of $g$ can be justified by requiring regret preferences to be consistent with the Allais' common consequence effect. Furthermore, Gee (2012) provides an axiomatic foundation for the convexity of $g$.

In the no-loss state, the FBA is to not have bought insurance coverage, i.e.

$$W_0^{\max} = w. \tag{3}$$

In the loss state, the FBA is to have bought the contract with the highest net coverage amongst

[6] We discuss the effect of overinsurance and taking a short position on the equilibrium outcome in Section 3.

[7] This two-attribute utility function is consistent with the axiomatic foundation of regret by Quiggin (1994) and Gee (2012).

the set of contracts offered. Let $X = (\tilde{I}, \tilde{c})$ denote the insurance contract with the highest net insurance coverage amongst the set of contracts offered with $0 \leq \tilde{I} \leq L$ and $\tilde{c} \geq p_L$, i.e., it is the contract with the highest value of $(1 - \tilde{c})\, \tilde{I}$.[8] Then,

$$W_1^{\max} = w - L + (1 - \tilde{c})\, \tilde{I}. \tag{4}$$

The level of expected utility of type $LR$ individuals is therefore

$$\begin{aligned} EU_{LR}(I, c) &= p_L \left(u(W_1) - g\left(u\left(W_1^{\max}\right) - u(W_1)\right)\right) \\ &\quad + (1 - p_L)\left(u(W_0) - g\left(u(w) - u(W_0)\right)\right) \end{aligned} \tag{5}$$

It is important to note that the expected utility of type $LR$ individuals depends upon the contract $X = (\tilde{I}, \tilde{c})$ since it impacts the level of $W_1^{\max}$.

Braun and Muermann (2004) show that regret-averse individuals "hedge their bets" by avoiding extreme decisions. That is, regret-averse individuals purchase more (less) insurance coverage than regret-neutral individuals if it is optimal for regret-neutral individuals to purchase very little (a lot of) insurance coverage. This implies that regret-averse individuals value insurance coverage relatively more (less) than regret-neutral individuals if an insurance contract offers very little (a lot of) coverage. In addition, high-risk type individuals value insurance coverage more than low-risk type individuals at any level of insurance coverage.

For the equilibrium analysis, we use figures to analyze equilibria for both scenarios. In all figures, the $x$-axis represents the individuals' level of final wealth in the no-loss state, $W_0$, whereas the $y$-axis denotes the individuals' level of final wealth in the loss state, $W_1$. The individuals' endowment point is $(w, w - L)$ and labeled $E$. $\mathbf{P}_H$, $\bar{\mathbf{P}}$, and $\mathbf{P}_L$ denote the set of wealth levels $(W_0, W_1)$ under insurance contracts $(I, c)$ with premium rates $c_H = (1 + \theta) p_H$, $\bar{c} = \lambda c_H + (1 - \lambda)\, c_L$, and $c_L = (1 + \theta) p_L$, respectively, where $\theta$ is the proportional insurance loading covering, for example, transaction costs.

[8] If overinsurance and/or taking a short position were allowed, then the FBA would be to have bought the contract with the largest net coverage or the largest short position amongst all contracts offered in the loss state or no-loss state, respectively.

From equation (1), the slope of type $HN$ individuals' indifference curve under contract $(I, c)$ is

$$\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(I,c)}} = -\frac{1-p_H}{p_H}\frac{u'(W_0)}{u'(W_1)} < 0.$$

Indifference curves are convex since

$$\begin{aligned}
\frac{d^2W_1}{dW_0^2}|_{\overline{EU_{HN}(I,c)}} &= -\frac{1-p_H}{p_H}\left[\frac{u''(W_0)\,u'(W_1) - u'(W_0)\,u''(W_1)\,\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(I,c)}}}{[u'(W_1)]^2}\right] \\
&= \left[\frac{u''(W_0)}{u'(W_0)} - \frac{u''(W_1)}{u'(W_1)}\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(I,c)}}\right]\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(I,c)}} > 0.
\end{aligned}$$

The slope of type $LR$ individuals' indifference curve is

$$\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}} = -\frac{1-p_L}{p_L}\frac{u'(W_0)}{u'(W_1)}\frac{1+g'(u(w)-u(W_0))}{1+g'(u(W_1^{\max})-u(W_1))} < 0. \tag{6}$$

The second derivative of type $LR$ individuals' indifference curve is given by

$$\begin{aligned}
\frac{d^2W_1}{dW_0^2}|_{\overline{EU_{LR}(I,c)}} &= \left[\frac{u''(W_0)}{u'(W_0)} - \frac{u''(W_1)}{u'(W_1)}\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}}\right]\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}} \\
&\quad -\frac{g''(u(w)-u(W_0))\,u'(W_0)}{1+g'(u(w)-u(W_0))}\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}} \\
&\quad +\frac{g''(u(W_1^{\max})-u(W_1))\,u'(W_1)}{[1+g'(u(W_1^{\max})-u(W_1))]}\left[\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}}\right]^2 \\
&> 0.
\end{aligned} \tag{7}$$

Type $LR$ individuals' indifference curves are thus also both decreasing and convex. Note that the shape of the indifference curves of type $LR$ individuals depends on the wealth level $W_1^{\max}$ under the foregone best alternative contract $X = (\tilde{I}, \tilde{c})$ that offers the highest net insurance coverage.

We next compare the marginal value of insurance coverage for type $LR$ individuals and type $HN$ individuals. For a given wealth level $W_1^{\max}$ of the FBA in the loss state, type $LR$ individuals marginally value insurance coverage less than type $HN$ individuals at a contract $(I, c)$ if type $LR$ individuals' indifference curves are steeper, i.e., if the slope is more negative. This is the case if

$$\frac{1-p_L}{p_L}\frac{1+g'(u(W_0^{\max})-u(W_0))}{1+g'(u(W_1^{\max})-u(W_1))} \geq \frac{1-p_H}{p_H}. \tag{8}$$

where $W_0 = w - cI$, $W_0^{\max} = w$, and $W_1 = w - L + (1-c)\, I$.

At full insurance coverage, $I = L$, we derive $W_0 = W_1 = w - cL$ and condition (8) is satisfied since $g$ is convex and $W_0^{\max} = w > W_1^{\max}$. That is, under a full insurance contract, type $LR$ individuals marginally value insurance coverage less than type $HN$ individuals. This is true for two reasons. Type $LR$ individuals are lower risk, $p_L < p_H$, and they prefer avoiding extreme decisions–full coverage in this case–to reduce their disutility derived from regret.

When moving away from full coverage by reducing insurance coverage $I$ at the same premium rate $c$, $W_0$ increases and $W_1$ decreases. Since $g$ is convex, $g'\left(u\left(W_0^{\max}\right) - u\left(W_0\right)\right)$ decreases and $g'\left(u(W_1^{\max}) - u\left(W_1\right)\right)$ increases. The willingness to pay for insurance of type $LR$ individuals decreases and condition (8) is less likely to hold. Formally, the effect of increasing the amount of coverage $I$ at the same premium rate $c$ on the left-hand side of condition (8) is positive since

$$\begin{aligned}
& \frac{\partial}{\partial I}\left(\frac{1+g'\left(u\left(w\right)-u\left(W_0\right)\right)}{1+g'\left(u(W_1^{\max})-u\left(W_1\right)\right)}\right) \\
= \; & \frac{cu'\left(W_0\right) g''\left(u\left(w\right)-u\left(W_0\right)\right)}{1+g'\left(u(W_1^{\max})-u\left(W_1\right)\right)} + \frac{\left(1-c\right) u'\left(W_1\right) g''\left(u(W_1^{\max})-u\left(W_1\right)\right)\left(1+g'\left(u\left(w\right)-u\left(W_0\right)\right)\right)}{\left(1+g'\left(u(W_1^{\max})-u\left(W_1\right)\right)\right)^2} \\
> \; & 0. \qquad (9)
\end{aligned}$$

The higher the level of insurance coverage, the steeper the type $LR$ individuals' indifference curves, that is, the lower the marginal value of insurance coverage for type $LR$ individuals.

If condition (8) is satisfied at the endowment point $E = (w, w-L)$, i.e., if

$$\frac{1-p_L}{p_L}\frac{1+g'\left(0\right)}{1+g'\left(u(W_1^{\max})-u\left(w-L\right)\right)} \geq \frac{1-p_H}{p_H}, \qquad (10)$$

then condition (9) implies that the indifference curves of type $LR$ individuals are always steeper than the ones of type $HN$ individuals for all insurance contracts $(I, c)$ with $0 \leq I \leq L$.

However, if at the endowment point $E = (w, w-L)$ condition (8) does not hold, then condition (9) implies that there exists a unique level insurance coverage $0 < \hat{I} < L$ such that condition (8) holds for all insurance contracts $(I, c)$ with $\hat{I} \leq I \leq L$. Moreover, condition (8) does not hold for all insurance contracts $(I, c)$ with $0 \leq I < \hat{I}$. At the level $\hat{I}$, the indifference curves of type $LR$ and type $HN$ individuals have the same slope, i.e., $\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(\hat{I},c)}} = \frac{dW_1}{dW_0}|_{\overline{EU_{LR}(\hat{I},c)}}$, and condition (8) is satisfied with equality. For this level of insurance coverage, we derive

$$\begin{aligned}
\frac{d^2W_1}{dW_0^2}|_{\overline{EU_{LR}(\hat{I},c)}} &= \frac{d^2W_1}{dW_0^2}|_{\overline{EU_{HN}(\hat{I},c)}} \\
&\quad - \frac{g''\left(u\left(w\right)-u\left(W_0\right)\right)u'\left(W_0\right)}{1+g'\left(u\left(w\right)-u\left(W_0\right)\right)}\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(\hat{I},c)}} \\
&\quad + \frac{g''\left(u(W_1^{\max})-u\left(W_1\right)\right)u'\left(W_1\right)}{\left[1+g'\left(u(W_1^{\max})-u\left(W_1\right)\right)\right]}\left[\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(\hat{I},c)}}\right]^2 \\
&> \frac{d^2W_1}{dW_0^2}|_{\overline{EU_{HN}(\hat{I},c)}} \qquad (11)
\end{aligned}$$

The indifference curve of type $LR$ individuals at $\hat{I}$ is thus more convex than the one of type $HN$ individuals for all premium rates $c$ and contracts $X$.

An interesting feature of regret is that preferences depend upon foregone alternatives. In particular, insurance companies can change the optimal choice of type $LR$ individuals by offering a contract $X$ with higher net insurance coverage $(1-\tilde{c})\,\tilde{I}$. The impact of increasing net insurance coverage of the foregone best alternative on the slope of the indifference curve of type $LR$ individuals is positive since

$$\frac{\partial}{\partial\left(1-\tilde{c}\right)\tilde{I}}\left(\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(I,c)}}\right) = -\frac{\partial}{\partial\left(1-\tilde{c}\right)\tilde{I}}\left(\frac{1+g'\left(u\left(w\right)-u\left(W_0\right)\right)}{1+g'\left(u(w-L+\left(1-\tilde{c}\right)\tilde{I})-u\left(W_1\right)\right)}\right) > 0.$$

This implies that the indifference curves of types $LR$ individuals become less steep at any contract $(I,c)$. The intuition is that increasing net insurance coverage of the foregone best alternative increases the regret in the loss state and thereby makes coverage relatively more valuable for type $LR$ individuals through reducing regret in the loss state. This also implies that offering a contract with a higher net insurance coverage increases the level of coverage $\hat{I}$ at which condition (8) holds with equality.

## 2.2 Scenario II: types $LN$ and $HR$ individuals

In this Scenario II, there are type $LN$ individuals and type $HR$ individuals in the market. Let $\psi$ be the fraction of type $HR$ individuals in the population. In this case, the level of expected utility for type $LN$ individuals is

$$EU_{LN}(I,c) = p_L u(W_1) + (1-p_L) u(W_0), \tag{12}$$

and the level of expected utility of type $HR$ individuals is

$$\begin{aligned} EU_{HR}(I,c) &= p_H \left(u(W_1) - g\left(u\left(W_1^{\max}\right) - u(W_1)\right)\right) \\ &\quad + (1-p_H)\left(u(W_0) - g\left(u\left(W_0^{\max}\right) - u(W_0)\right)\right). \end{aligned} \tag{13}$$

The slope of type $LN$ individuals' indifference curve under contract $(I,c)$ is

$$\frac{dW_1}{dW_0}|_{\overline{EU_{LN}(I,c)}} = -\frac{1-p_L}{p_L}\frac{u'(W_0)}{u'(W_1)},$$

and that of type $HR$ individuals' indifference curve is

$$\frac{dW_1}{dW_0}|_{\overline{EU_{HR}(I,c)}} = -\frac{1-p_H}{p_H}\frac{u'(W_0)}{u'(W_1)}\frac{1+g'(u(w)-u(W_0))}{1+g'(u(W_1^{\max})-u(W_1))} < 0. \tag{14}$$

Analogously to the analysis in Scenario I, both type $LN$ individuals's indifference curves and type $HR$ individuals' indifference curves are decreasing and convex.

The indifference curve of type $HR$ individuals is less steep than the one of type $LN$ individuals if and only if

$$\frac{1-p_H}{p_H}\frac{1+g'(u(w)-u(W_0))}{1+g'(u(W_1^{\max})-u(W_1))} \leq \frac{1-p_L}{p_L}. \tag{15}$$

In contrast to Scenario I, this condition holds at the endowment point $E=(w, w-L)$, but not necessarily at full insurance coverage. Without insurance coverage, type $HR$ individuals marginally value insurance coverage relatively more than type $LN$ individuals because they are higher risk and because they prefer avoiding extreme decisions–no insurance in this case–due to regret.

The effect of increasing the amount of coverage $I$ at the same premium rate $c$ on the left-hand side of condition (15) is still positive. The higher the level of insurance coverage, the lower the marginal value of insurance coverage for type $HR$ individuals.

If condition (15) is also satisfied at full insurance coverage, then it is satisfied for all insurance contracts $(I, c)$ with $0 \leq I \leq L$.

However, if at full insurance coverage condition (15) does not hold, then there exists a unique level of insurance coverage $0 < \hat{I} < L$ such that condition (15) holds for all insurance contracts $(I, c)$ with $0 \leq I \leq \hat{I}$. Moreover, condition (15) does not hold for all insurance contracts $(I, c)$ with $\hat{I} < I \leq L$. At the level $\hat{I}$, the indifference curves of type $LN$ and type $HR$ individuals have the same slope, i.e. condition (15) is satisfied with equality, i.e., $\frac{dW_1}{dW_0}|_{\overline{EU_{LN}(\hat{I},c)}} = \frac{dW_1}{dW_0}|_{\overline{EU_{HR}(\hat{I},c)}}$. Analogously to Scenario I, the indifference curve of type $HR$ individuals is more convex than the one of type $LN$ individuals at $I = \hat{I}$, for all premium rates $c$ and contracts $X$.

# 3 Equilibrium Analysis

We consider the following sequence of events:

**Stage 1** Insurers make binding offers of insurance contracts specifying coverage $I$ and premium rate $c$.

**Stage 2** Individuals choose either a contract from the set of contracts offered or no contract. If the same contract is offered by two insurers, individuals toss a fair coin.

Rothschild and Stiglitz (1976) define the equilibrium set of contracts as the set of contracts such that each contract offered in equilibrium earns non-negative expected profits and such that there does not exist a contract outside the equilibrium set of contracts which earns, if added, non-negative expected profits.

As examined above, regret introduces two interesting features that have a profound impact on the properties of the equilibrium outcomes. First, the relative valuation of insurance coverage between the two types depends on the amount of insurance coverage offered. Regret-averse individuals value insurance relatively more (less) than regret-neutral individuals if the level of coverage offered is small (large). Second, the foregone best alternative and thus the optimal choice of regret-averse individuals depends on the set of contracts offered. These have important implications for the equilibrium outcomes.

First, the heterogeneity in valuation of insurance coverage, even at their risk types' respectively fair premium rates, relaxes the self-selection constraints and thereby makes separation easier. In fact, we show that the self-selection constraints due to asymmetric information can be both satisfied for the equilibrium contracts under full information. In this case, there is no inefficiency due to asymmetric information.

The second implication is that the correlation between the level of insurance coverage and risk type can be positive or negative depending on the relation between risk types and regret preferences. If regret-neutral individuals are high-risk types, then full coverage is optimal for them and the self-selection constraint for low-risk and regret-averse individuals—might it be binding or not—implies partial coverage for them. In this case, the separating equilibrium has the property that the level of insurance coverage and risk type are positively related. If, however, regret-neutral individuals are low-risk types, then low-risk types are fully insured and high-risk types are only partially insured in the separating equilibrium. The correlation between the level of insurance coverage and risk type is negative.

In addition to the relation between risk types and regret preferences, the loading factor of premium rates plays an important role in our setting with regret-averse individuals. If there are no transaction costs and competition implies actuarially fair premium rates, then full insurance coverage is optimal for regret-neutral individuals. In contrast, regret-averse individuals prefer partial coverage at actuarially fair rates. However, if insurance is priced with high loadings, e.g., due to high transaction costs, then little insurance coverage is optimal for regret-neutral individuals and regret-averse individuals prefer more coverage (see Braun and Muermann, 2004). In a separating equilibrium, the correlation between the level of insurance coverage and risk types would then be opposite when comparing a market with actuarially fair rates with a market with high loadings.

Chiappori et al. (2006) show that the prediction about the positive correlation between insurance coverage and expected value of indemnity can be extended from the settings of the traditional adverse selection or moral hazard models to more general settings. These extensions include coexistence of adverse selection and moral hazard, heterogeneous preferences, multiple levels of losses, and multidimensional hidden information linked with hidden action. Their result is based on the assumptions that individuals have monotonic preferences, dislike mean-preserving spreads, and base their decisions on the true loss distribution, i.e., their risk perception is not biased, for example, through optimism or overconfidence. Moreover, it is assumed that insurers' profits are non-increasing in insurance coverage. The important difference in our setting that implies a negative correlation between insurance coverage and risk in equilibrium is that individuals with regret-averse preferences prefer mean-preserving spreads under some wealth distribution. The reason is that mean-preserving spreads can reduce anticipatory regret. Consider full insurance at actuarially fair premium rates. Partial insurance—which is identical to a adding a mean-preserving spread to the wealth levels under full insurance—is preferred by regret-averse individuals since the reduction in regret if the loss does not realize outweighs the additional regret if the loss realizes.[9]

Last, the fact that optimal choice of regret-averse individuals depends on the set of contracts offered allows for an interesting strategy for competing insurers. Suppose a regret-averse individual is insured under a contract from an incumbent insurance company. A competing insurance company could strategically offer two contracts: one contract is only offered to alter the optimal choice of the regret-averse individual by changing the foregone best alternative, and the other contract serves the purpose of attracting the individual given the shift in the optimal choice of the regret-averse individual. We can restrict our strategies to those where the former contract, which we denote contract $X$, offers higher net insurance coverage than the other contracts offered as only higher net insurance coverage changes the foregone best alternative and thereby the optimal choice of regret-averse individuals.[10] To accommodate for this strategy, we modify the equilibrium concept by Rothschild and Stiglitz (1976) in the following way: the equilibrium set of contracts is the set of contracts such that each contract offered in equilibrium earns non-negative expected profits and such that there neither exists a single contract nor a pair of contracts outside the equilibrium set of contracts which each earn, if added, non-negative expected profits. As in Rothschild and Stiglitz (1976) we do not consider a pair of cross-subsidizing contracts. Note that it would not be possible to cross-subsidize a contract with contract $X$ as contract $X$ is not purchased in equilibrium. If insurance companies were not allowed to offer contract $X$ alongside with a second contract, then our results remain valid under the equilibrium concept of Rothschild and Stiglitz (1976).

In the following, we analyze the equilibrium outcome for the two distributions of types, Scenario I and II.

[9] This is a direct consequence of the convexity of $g(\cdot)$. Individuals are *correlation-loving* (see Eeckhoudt et al., 2007) in the two attributes of the utility function, $W$ and $W^{\max}$. This is intuitive in our context since utility is increasing in wealth, $W$, but decreasing in the maximum wealth the individual could have obtained, $W^{\max}$.

[10] In the no-loss state, the foregone best alternative (FBA) is to have rejected all insurance contracts. We implicitly assume that insurers cannot change this FBA, e.g., by offering to take a short position. We later discuss the effects of overinsurance and shortselling.

### 3.1 Scenario I: types $HN$ and $LR$ individuals

Suppose first that there are no transaction costs and competition drives premium rates down to actuarially fair rates. In Figures 1 to 7, we denote by $A_{HN}$ and $A_{LR}$ the equilibrium contracts under full information for type $HN$ and $LR$ individuals, respectively. With no insurance loading, $A_{HN} = (L, p_H)$ is the full coverage contract at a premium rate $p_H$. In contrast, regret-averse individuals optimally demand partial coverage at actuarially fair premium rates (see Braun and Muermann, 2004). Thus, $A_{LR}$ is the optimal partial coverage contract at a premium rate $p_L$. Let $C_{HN}$ and $C_{LR}$ denote the equilibrium contracts under asymmetric information for types $HN$ and $LR$ individuals, respectively. Furthermore, let $B$ denote the contract where the indifference curve of type $HN$ individuals with contract $A_{HN}$ intersects the pricing line $\mathbf{P}_L$. With no insurance loading, contract $B$ is thus the contract analogous to the partial insurance contract chosen by low-risk types in the Rothschild and Stiglitz separating equilibrium.

In the following Proposition, we determine the properties of the equilibrium in this setting.

**Proposition 1** *Suppose there are no transaction costs and there are types $HN$ and $LR$ individuals. Then the equilibrium has the following properties.*

1. *There does not exist a pooling equilibrium.*

2. *If $EU_{HN}(A_{HN}) \geq EU_{HN}(A_{LR})$, as shown in Figure 1, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HN} = A_{HN}$ and $C_{LR} = A_{LR}$. The equilibrium coincides with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive.*

3. *If $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$, $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$, and the indifference curve of $EU_{LR}(B)$ does not intersect $\bar{\mathbf{P}}$, as shown in Figure 2, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HN} = A_{HN}$ and $C_{LR} = B$. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive.*

4. *If $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$, $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| > \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$, and the indifference curve of $EU_{LR}(\hat{C})$ does not intersect $\bar{\mathbf{P}}$, where $\hat{C}$ is defined through $EU_{HN}(\hat{C}) = EU_{HN}(A_{HN})$*

*and* $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(C_{LR})}}\right| = \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(C_{LR})}}\right|$*, as shown in Figure 3, then the equilibrium is a semi-pooling equilibrium with equilibrium contracts* $C_{HN} = A_{HN}$ *and* $\hat{C}$ *and* $C_{LR} = \hat{C}$*. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive.*

*In all cases, the equilibrium contract* $X$ *is* $A_{HN}$*, i.e.,* $X = (L, p_H)$*.*

**Proof.** See Appendix A.1. ■

In line with Rothschild and Stiglitz (1976), we find that a pooling equilibrium does not exist and, if an equilibrium exists, the correlation between the level of insurance coverage and risk type is positive. In contrast to Rothschild and Stiglitz (1976), we find that asymmetric information might not induce any inefficiency and the full-information equilibrium can be obtained. Last, a semi-pooling equilibrium might exist. In the semi-pooling equilibrium, a fraction of type $HN$ individuals purchase contract $C_{LR}$ such that providing $C_{LR}$ is does not generate strictly positive expected profits. Note that the equilibrium contract $X$ is $A_{HN}$ in the above scenario. This implies that only two contracts are offered in equilibrium. As in Rothschild and Stiglitz (1976), the equilibrium does not exist if the number of low risk type individuals, $1 - \lambda$, is so large that the indifference curve of $EU_{LR}(B)$ intersects the average pricing line $\bar{\mathbf{P}}$.

Chiappori et al. (2006) and Liu and Browne (2007) show that the qualitative results of Rothschild and Stiglitz (1976) still hold if individuals are heterogeneous with respect to their degree of risk aversion. In comparison, Proposition 1 shows that heterogeneity in regret preferences can alter the properties of the equilibrium outcome. The reason is that, at actuarially fair premium rates, regret-averse individuals prefer partial insurance over full insurance which identical to preferring a mean-preserving spread. This difference implies that the full-information equilibrium can be obtained.

If overinsurance and/or taking a short position were allowed, the qualitative results of the equilibrium analysis hold as long as overinsurance and shortselling is bounded. Suppose $\underline{I} \leq I \leq \overline{I}$ with $-\infty < \underline{I} \leq 0$ and $L \leq \overline{I} < \infty$. Then in all equilibria two contracts, $X$ and $Y$, are offered in addition to the contracts that are chosen in equilibrium. Contract $X$, as before, offers the highest possible wealth level in the loss state under the constraint that the contract is not purchased in equilibrium. If overinsurance up to coverage $\overline{I}$ is allowed, then $X = \left(\overline{I}, \overline{c}\right)$ where the premium rate

$\overline{c}$ is determined by $\min\{EU_{HN}(X), EU_{LR}(X)\} = \min\{EU_{HN}(C_{HN}), EU_{LR}(C_{LR})\}$. Contract $Y$ offers the highest possible wealth level in the no-loss state. If taking a short position is allowed up to $\underline{I}$, then $Y = (\underline{I}, \underline{c})$ where the premium rate $\underline{c}$ is determined by $\min\{EU_{HN}(Y), EU_{LR}(Y)\} = \min\{EU_{HN}(C_{HN}), EU_{LR}(C_{LR})\}$. The same properties of the equilibria obtain under this extension of the contract space. If overinsurance and/or shortselling were unbounded, then no equilibrium exists since any contract can be successfully attacked by a contract in combination with even more overinsurance or shortselling as foregone best alternatives.

We now assume that insurance transactions involve considerable transaction costs such that the loading factors have to be sufficiently large to cover those costs. In particular, we assume that the proportional loading factor $\theta$ exceeds a threshold $\bar{\theta}$ such that (a) the coverage of contract $A_{LR}$ is greater than that of contract $A_{HN}$ and (b) $EU_{HN}(A_{HN}) \geq EU_{HN}(L, (1+\theta)p_L)$. Braun and Muermann (2004) show that such loading factors exist under which regret-averse individuals—type $LR$ individuals here—demand more insurance than regret-neutral individuals—type $HN$ individuals here.

In the following Proposition, we determine the properties of the equilibrium in this setting.

**Proposition 2** *Suppose there are transaction costs such that loading factor $\theta$ exceeds $\bar{\theta}$ and there are types $HN$ and $LR$ individuals. Then the equilibrium has the following properties.*

1. *If $EU_{HN}(A_{HN}) \geq EU_{HN}(A_{LR})$, as shown in Figure 4, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HN} = A_{HN}$ and $C_{LR} = A_{LR}$. The equilibrium coincides with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is negative.*

2. *If $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$, $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| > \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$, and the indifference curve of $EU_{LR}(B)$ does not intersect $\bar{\mathbf{P}}$, as shown in Figure 5, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HN} = A_{HN}$ and $C_{LR} = B$. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is negative.*

3. *If $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$, $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$, the indifference curve of $EU_{LR}(\hat{C})$ is steeper than $\bar{\mathbf{P}}$ at $\hat{C}$ and does not intersect $\bar{\mathbf{P}}$, where $\hat{C}$ is defined through*

*$EU_{HN}(\hat{C}) = EU_{HN}(A_{HN})$ and $\left|\frac{dW_1}{dW_0}|_{EU_{HN}(\hat{C})}\right| = \left|\frac{dW_1}{dW_0}|_{EU_{LR}(\hat{C})}\right|$, as shown in Figure 6, then the equilibrium is a semi-pooling equilibrium with equilibrium contracts $C_{HN} = A_{HN}$ and $\hat{C}$, and $C_{LR} = \hat{C}$. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is negative.*

4. *If $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$, $\left|\frac{dW_1}{dW_0}|_{EU_{HN}(B)}\right| < \left|\frac{dW_1}{dW_0}|_{EU_{LR}(B)}\right|$, the indifference curve of $EU_{LR}(\hat{C})$ is tangent to $\bar{\mathbf{P}}$ at $\hat{C}$, as shown in Figure 7, then the equilibrium is a pooling equilibrium with equilibrium contract $C_{HN} = C_{LR} = \hat{C}$. The equilibrium does not coincide with the equilibrium under full information.*

*In all cases, the equilibrium set of contracts includes in addition contract $X$ which offers full coverage at the premium rate $(1+\theta)\,p_L$, i.e., $X = (L, (1+\theta)\,p_L)$.*

**Proof.** See Appendix A.2. ■

Proposition 2 shows that introducing both transaction costs and heterogeneity in regret preferences dramatically changes the results and predictions of Rothschild and Stiglitz (1976). We find that a pooling equilibrium can exist and that a separating equilibrium can exist that coincides with the equilibrium under full information. With high transaction costs, the correlation between the level of insurance coverage and risk type is negative in a separating equilibrium. The reason is that regret-aversion implies that type $LR$ individuals value insurance coverage relatively more at high loading factors than type $HN$ individuals. The self-selection constraint then implies that, in equilibrium, type $LR$ individuals purchase more insurance coverage than type $HN$ individuals. As mentioned before, if overinsurance and shortselling were allowed but bounded, then the same qualitative results obtain.

### 3.2 Scenario II: types $LN$ and $HR$ individuals

We now examine Scenario II with types $LN$ and $HR$ individuals in the market. Suppose again first that there are no transaction costs and competition drives premium rates down to actuarially fair rates. In Figures 8 to 11, we analogously denote by $A_{HR}$ and $A_{LN}$ the equilibrium contracts under full information for type $HR$ and $LN$ individuals, respectively. There is no insurance loading in equilibrium and $A_{LN} = (L, p_L)$ is the full coverage contract at a premium rate $p_L$. $A_{HR}$ is the optimal partial coverage contract for type $HR$ individuals at the premium rate $p_H$. Similarly, let

$C_{HR}$ and $C_{LN}$ denote the equilibrium contracts under asymmetric information for types $HR$ and $LN$ individuals, respectively. Last, let $B$ denote the contract where the indifference curve of type $HR$ individuals with contract $A_{HR}$ intersects the pricing line $\mathbf{P}_L$.

In the following Proposition, we determine the properties of the equilibrium in this setting.

**Proposition 3** *Suppose there are no transaction costs and there are types $HR$ and $LN$ individuals. Then the equilibrium has the following properties.*

1. *There does not exist a pooling equilibrium.*

2. *If $EU_{HR}(A_{HR}) \geq EU_{HR}(A_{LN})$, as shown in Figure 8, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HR} = A_{HR}$ and $C_{LN} = A_{LN}$. The equilibrium coincides with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is negative. The equilibrium contract $X$ is $A_{LN}$, i.e., $X = (L, p_L)$.*

3. *If $EU_{HR}(A_{HR}) < EU_{HR}(A_{LN})$, $\left|\frac{dW_1}{dW_0}\Big|_{\overline{EU_{HR}(B)}}\right| < \left|\frac{dW_1}{dW_0}\Big|_{\overline{EU_{LN}(B)}}\right|$, and the indifference curve of $EU_{LN}(B)$ does not intersect $\bar{\mathbf{P}}$, as shown in Figure 9, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HR} = A_{HR}$ and $C_{LN} = B$. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive. The equilibrium contract $X$ is the full coverage contract on the 45-degree line on the indifference curve of $EU_{HR}(A_{HR})$.*

**Proof.** See Appendix A.3. ■

We find that only a separating equilibrium can exist, as in Rothschild and Stiglitz (1976). However, the full information equilibrium can be obtained under heterogeneity in regret preferences. Since regret-averse individuals are high-risk types in this scenario, they prefer partial coverage over full coverage at actuarially fair rates. The self-selection constraints can be satisfied for the equilibrium contracts under full information in which case there is no inefficiency. The correlation between the level of insurance coverage and risk type is negative. If the self-selection constraint for type $LN$ individuals is binding, then type $LN$ individuals have less insurance coverage than type $HR$ individuals and the separating equilibrium exhibits a positive correlation between the level of insurance coverage and risk type. Again, we implicitly assume that the fraction of high risk type individuals, $\psi$, is large enough such that the indifference curve of $EU_{LN}(B)$ does not intersect the average pricing line $\bar{\mathbf{P}}$. Otherwise, an equilibrium does not exist.

Last, we examine the case with high transaction costs. We assume that the proportional loading factor $\theta$ exceeds a threshold $\bar{\theta}$ such that (a) the coverage of contract $A_{HR}$ is greater than that of contract $A_{LN}$ and (b) $EU_{HR}(A_{HR}) \geq EU_{HR}(L, (1+\theta)p_L)$.

The properties of the equilibrium in this setting are as follows.

**Proposition 4** *Suppose there are transaction costs such that loading factor $\theta$ exceeds $\bar{\theta}$ and there are types $HR$ and $LN$ individuals. Then the equilibrium has the following properties.*

1. *There does not exist a pooling equilibrium.*

2. *If $EU_{HR}(A_{HR}) \geq EU_{HR}(A_{LN})$, as shown in Figure 10, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HR} = A_{HR}$ and $C_{LN} = A_{LN}$. The equilibrium coincides with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive.*

3. *If $EU_{HR}(A_{HR}) < EU_{HR}(A_{LN})$ and $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HR}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LN}(B)}}\right|$, and indifference curve of $EU_{LR}(B)$ does not intersect $\bar{\mathbf{P}}$, as shown by Figure 11, then the equilibrium is a separating equilibrium with equilibrium contracts $C_{HR} = A_{HR}$ and $C_{LN} = B$. The equilibrium does not coincide with the equilibrium under full information and the correlation between the level of insurance coverage and risk type is positive.*

   *In all cases, the equilibrium contract $X$ is the full coverage contract on the 45-degree line on the indifference curve of $EU_{HR}(A_{HR})$.*

**Proof.** See Appendix A.4. ■

### 3.3 Summary

We summarize the results of the equilibrium analysis in the following table:

| | Low risk types are regret-averse | High risk types are regret-averse |
|---|---|---|
| No loading | Positive correlation coverage/risk<br>Full information (Figure 1)<br>Separating (Figure 2)<br>Semi-pooling (Figure 3) | Negative correlation coverage/risk<br>Full information (Figure 8)<br>Positive correlation coverage/risk<br>Separating (Figure 9) |
| High loading | Negative correlation coverage/risk<br>Full information (Figure 4)<br>Separating (Figure 5)<br>Semi-pooling (Figure 6)<br>Pooling (Figure 7) | Positive correlation coverage/risk<br>Full information (Figure 10)<br>Separating (Figure 11) |

With no loading, the qualitative properties of the separating equilibrium of Rothschild and Stiglitz (1976) are robust to the introduction of low levels of regret-aversion to the preferences of either the low risk types (see Figure 2) or the high risk types (see Figure 9). For high levels of regret-aversion, however, the equilibrium contract of low risk types under full information can satisfy the self-selection constraint and the equilibrium under full information is obtained. If low risk individuals are regret-averse, then high risk types are fully insured and low risk types are partially insured. The correlation between insurance coverage and risk is positive (see Figure 1). In contrast, if high risk individuals are regret-averse, then they are partially insured but low risk types are fully insured. The correlation between insurance coverage and risk is then negative positive (see Figure 8).

If the loading factor is high enough, then results change for two reasons. First, independent of regret preferences, both risk types prefer partial coverage due to the loading. Second, regret-averse individuals prefer more coverage compared to regret-neutral individuals (see Braun and Muermann, 2004). If low risk types are regret-averse, then they receive more coverage in equilibrium compared to high risk, regret-neutral individuals (see Figures 4 - 6). The correlation between insurance coverage and risk is negative. If the level of regret-aversion is high enough, the equilibrium under full information can be obtained (see Figure 4). For an intermediate level of regret-aversion, a pooling equilibrium can exist (see Figure 7). If high risk types are regret-averse, then they receive more coverage in equilibrium compared to low risk, regret-neutral individuals (see Figures 10 and 11). The correlation between insurance coverage and risk and positive. Again, if the level of regret-aversion is high enough, the equilibrium under full information can be obtained (see Figure 10).

# 4 Conclusion

In this paper, we analyzed equilibria in insurance markets with two-dimensional asymmetric information on risk type and on preferences related to regret. We have shown that the full information equilibrium can be obtained. Moreover, pooling, semi-pooling, and separating equilibria can exist. There exist separating equilibria with negative and with positive correlation between insurance coverage and risk type. Different to other two-dimensional asymmetric information models, the optimal choice of regretful customers depends on foregone alternatives. This implies that any equilibrium includes a contract which is offered but not necessarily purchased.

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# Appendix A: Proofs

## A.1 Proof of Proposition 1

The equilibrium analysis is based on figures.

1. A pooling equilibrium does not exist.

   The proof is similar to the one in Rothschild and Stiglitz (1976). For any contract located on the average pricing line $\bar{\mathbf{P}}$, the indifference curve of type $HN$ is flatter than $\bar{\mathbf{P}}$ since

   $$\frac{1-p_H}{p_H}\frac{u'(W_0)}{u'(W_1)} \leq \frac{1-(\lambda p_H+(1-\lambda)p_L)}{(\lambda p_H+(1-\lambda)p_L)}. \tag{A.1}$$

   Note that $u$ is concave and $p_H \geq (\lambda p_H + (1-\lambda)p_L)$. If the indifference curve of type $LR$ is steeper than that of type $HN$ on $\bar{\mathbf{P}}$, then contract $\hat{C}$, as shown in Figure A.1, is a possible equilibrium pooling contract. However, Figure A.1 indicates that there exists a contract $C'$ located in the region surrounded by the indifference curves $EU^*_{LR}$, $EU^*_{HN}$ and the pricing line $\mathbf{P}_L$ which is preferred to contract $\hat{C}$ only by type $LR$ and thus earns non-negative expected profits.

   If the indifference curve of type $LR$ is flatter than or is tangent to that of type $HN$ on $\bar{\mathbf{P}}$, then contract $\hat{C}$, as shown in Figure A.2, is a possible equilibrium pooling contract. However, contract $C'$ on $\bar{\mathbf{P}}$ which offers slightly more coverage than $\hat{C}$, as shown in Figure A.2, is preferred by both types and earns non-negative expected profits.

2. Let $B = (I_B, p_L)$, as shown in Figure 1, denote the contract at which type $HN$ is indifferent between this contract and $A_{HN}$, i.e., the level of coverage $I_B$ is determined by

   $$EU_{HN}(A_{HN}) = u(w-p_H L) = p_H u(w-L+(1-p_L)I_B) + (1-p_H)u(w-p_L I_B). \tag{A.2}$$

   The condition $EU_{HN}(A_{HN}) \geq EU_{HN}(A_{LR})$ implies that the level of coverage $I_B$ is greater than the one of contract $A_{LR}$ and that the self-selection constraint for type $HN$ is satisfied. Since $A_{LR}$ is the optimal contract for type $LR$ at the premium rate $c = p_L$, it is also the optimal contract at any premium rate $c \geq p_L$. The self-selection constraint for type $LR$ is satisfied as well. Last, insurance companies cannot offer any contract which contains higher net coverage as the FBA in the loss state but is not chosen by both types of individuals.

3. The equilibrium is illustrated in Figure 2. Condition $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$ implies that the indifference curve of type $LR$ individuals at point $B$ is flatter than the pricing line $\mathbf{P}_L$, i.e.,

$$\begin{aligned} & \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-p_L I_B\right)\right)}{1+g'\left(\left(1-p_H\right)\left[u\left(w-p_L I_B\right)-u\left(w-L+\left(1-p_L\right)I_B\right)\right]\right)} \\ & \times\frac{u'\left(w-p_L I_B\right)}{u'\left(w-L+\left(1-p_L\right)I_B\right)} \\ \leq\; & \frac{1-p_L}{p_L}. \end{aligned} \tag{A.3}$$

Condition $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$ is equivalent to the indifference curve of type $HN$ being flatter than that of type $LR$ at point $B$, i.e.,

$$\begin{aligned} & \frac{1-p_H}{p_H}\frac{u'\left(w-p_L I_B\right)}{u'\left(w-L+\left(1-p_L\right)I_B\right)} \\ <\; & \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-p_L I_B\right)\right)}{1+g'\left(\left(1-p_H\right)\left[u\left(w-p_L I_B\right)-u\left(w-L+\left(1-p_L\right)I_B\right)\right]\right)} \\ & \times\frac{u'\left(w-p_L I_B\right)}{u'\left(w-L+\left(1-p_L\right)I_B\right)}. \end{aligned} \tag{A.4}$$

If conditions (A.3) and (A.4) hold and the proportion of type $HN$ is large enough, then, as shown in Figure 2, the self-selection constraints of both types are satisfied and there is no other profitable contract that is preferred only by type $LR$ individuals. It is also not possible to offer any other contract besides $A_{HN}$ which contains higher net coverage as the FBA in the loss state but is not chosen by either types of individuals.

4. The equilibrium is illustrated in Figure 3. $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$ implies

$$\begin{aligned} & \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-p_L I_B\right)\right)}{1+g'\left(\left(1-p_H\right)\left[u\left(w-p_L I_B\right)-u\left(w-L+\left(1-p_L\right)I_B\right)\right]\right)} \\ & \times\frac{u'\left(w-p_L I_B\right)}{u'\left(w-L+\left(1-p_L\right)I_B\right)} \\ \leq\; & \frac{1-p_L}{p_L}. \end{aligned} \tag{A.5}$$

and $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(B)}}\right| > \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(B)}}\right|$ is equivalent to

$$\begin{aligned} & \frac{1-p_H}{p_H}\frac{u'(w-p_LI_B)}{u'(w-L+(1-p_L)I_B)} \\ > \; & \frac{1-p_L}{p_L}\frac{1+g'(u(w)-u(w-p_LI_B))}{1+g'((1-p_H)[u(w-p_LI_B)-u(w-L+(1-p_L)I_B)])} \\ & \times\frac{u'(w-p_LI_B)}{u'(w-L+(1-p_L)I_B)}. \end{aligned} \tag{A.6}$$

In this case, type $LR$ marginally value insurance more than type $HN$ at point $B$. As discussed in Section 2, type $LR$ individuals value insurance less than type $HN$ individuals at full coverage. Thus, there exists a unique contract $\hat{I}$ such that the indifference curves of type $LR$ and type $HN$ individuals have the same slope. As shown in Figure 3, $C_{LR} = \hat{C}$ denotes the contract at which $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HN}(A_{HN})}}\right| = \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LR}(C_{LR})}}\right|$. If $EU_{LR}(C_{LR})$ does not intersect $\bar{\mathbf{P}}$, then insurance companies cannot offer any contract that attracts type $LR$ and earns non-negative expected profits.

## A.2 Proof of Proposition 2

1. The equilibrium is illustrated in Figure 4. Let $B = (I_B, p_L)$ and $A_{HN} = (I^*_{HN}, p_H)$. Then

$$\begin{aligned} & p_Hu(w-L+I_B-(1+\theta)p_LI_B)+(1-p_H)u(w-(1+\theta)p_LI_B) \\ = \; & p_Hu(w-L+I_B-(1+\theta)p_HI^*_{HN})+(1-p_H)u(w-(1+\theta)p_HI^*_{HN}). \end{aligned} \tag{A.7}$$

   The condition $EU_{HN}(A_{HN}) \geq EU_{HN}(A_{LR})$ implies that the level of coverage $I_B$ of contract $B$ is greater than the level of coverage $I^*_{HN}$ of contract $A_{LR}$ and that the self-selection constraint for type $HN$ is satisfied. Since $A_{LR}$ is the optimal contract for type $LR$ at the premium rate $c = p_L$, it is also the optimal contract at any premium rate $c \geq p_L$. The self-selection constraint for type $LR$ is satisfied as well. Last, insurance companies cannot offer any contract which contains higher net coverage as the FBA in the loss state but is not chosen by either types of individuals.

2. Figure 5 illustrates the equilibrium. Condition $EU_{HN}(A_{HN}) < EU_{HN}(A_{LR})$ implies that the indifference curve of type $LR$ individuals at point $B$ is steeper than the pricing line $\mathbf{P}_L$,

i.e.,

$$
\begin{aligned}
& \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-\left(1+\theta\right)p_L I_B\right)\right)}{1+g'\left(u\left(w-\left(1+\theta\right)p_L L\right)-u\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)\right)} \\
& \times\frac{u'\left(w-\left(1+\theta\right)p_L I_B\right)}{u'\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)} \\
\geq\ & \frac{1-\left(1+\theta\right)p_L}{\left(1+\theta\right)p_L}.
\end{aligned}
\tag{A.8}
$$

Furthermore, $\left|\frac{dW_1}{dW_0}|_{EU_{HN}(B)}\right| > \left|\frac{dW_1}{dW_0}|_{EU_{LR}(B)}\right|$ is equivalent to the indifference curve of type $HN$ being steeper than that of type $LR$ at point $B$, i.e.,

$$
\begin{aligned}
& \frac{1-p_H}{p_H}\frac{u'\left(w-\left(1+\theta\right)p_L I_B\right)}{u'\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)} \\
>\ & \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-p_L I_B\right)\right)}{1+g'\left(\left(1-p_H\right)\left[u\left(w-p_L I_B\right)-u\left(w-L+\left(1-p_L\right)I_B\right)\right]\right)} \\
& \times\frac{u'\left(w-\left(1+\theta\right)p_L I_B\right)}{u'\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)}.
\end{aligned}
\tag{A.9}
$$

Combining conditions (A.8) and (A.9) yields

$$
\frac{p_L\left(1-p_H\right)}{p_H\left(1-p_L\right)} < \frac{1+g'\left(u\left(w\right)-u\left(w-p_L I_B\right)\right)}{1+g'\left(\left(1-p_H\right)\left[u\left(w-p_L I_B\right)-u\left(w-L+\left(1-p_L\right)I_B\right)\right]\right)} \leq 1. \tag{A.10}
$$

If the above condition holds and the proportion of type $HN$ is large enough, then, as shown in Figure 5, the self-selection constraints of both types are satisfied and there is no other profitable contract that is preferred only by type $LR$ individuals. It is also not possible to offer any other contract besides $A_{HN}$ which contains higher net coverage as the FBA in the loss state but is not chosen by either types of individuals.

3. Figure 6 illustrates the equilibrium. $\left|\frac{dW_1}{dW_0}|_{EU_{HN}(B)}\right| < \left|\frac{dW_1}{dW_0}|_{EU_{LR}(B)}\right|$ is equivalent to

$$
\begin{aligned}
& \frac{1-p_H}{p_H}\frac{u'\left(w-\left(1+\theta\right)p_L I_B\right)}{u'\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)} \\
<\ & \frac{1-p_L}{p_L}\frac{1+g'\left(u\left(w\right)-u\left(w-\left(1+\theta\right)p_L I_B\right)\right)}{1+g'\left(u\left(w-\left(1+\theta\right)p_L L\right)-u\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)\right)} \\
& \times\frac{u'\left(w-\left(1+\theta\right)p_L I_B\right)}{u'\left(w-L+\left(1-\left(1+\theta\right)p_L\right)I_B\right)}.
\end{aligned}
\tag{A.11}
$$

In this case, type $HN$ marginally value insurance more than type $LR$ individuals at point $B$. As discussed in Section 2, there exists a unique contract $\hat{C} \equiv (\hat{I}, \hat{c})$ such that the indifference curves of type $LR$ and type $HN$ individuals have the same slope. If $EU_{LR}(C_{LR})$ does not intersect $\bar{\mathbf{P}}$ and if the indifference curve of $EU_{LR}\left(\hat{C}\right)$ is stepper than $\bar{\mathbf{P}}$ at $\hat{C}$, then insurance companies cannot offer any contract that attracts type $LR$ and earns non-negative expected profits.

4. Figure 7 illustrates the equilibrium. The equilibrium conditions are the same as the above case except that the indifference curve of $EU_{LR}(\hat{C})$ is is tangent to $\bar{\mathbf{P}}$ at $\hat{C}$, i.e.,

$$\begin{aligned} & \frac{1-p_L}{p_L} \frac{1+g'\left(u\left(w\right)-u\left(w-\hat{c}\hat{I}\right)\right)}{1+g'\left(u\left(w-(1+\theta)\,p_L L\right)-u\left(w-L+(1-\hat{c})\,\hat{I}\right)\right)} \\ & \times \frac{u'\left(w-\hat{c}\hat{I}\right)}{u'\left(w-L+(1-\hat{c})\,\hat{I}\right)} \\ = \; & \frac{1-[\lambda(1+\theta)p_H+(1-\lambda)\,(1+\theta)p_L]}{\lambda(1+\theta)p_H+(1-\lambda)\,(1+\theta)p_L}. \end{aligned} \tag{A.12}$$

Figure 7 shows that no profitable contract can be offered that attracts individuals and earns non-negative expected profits.

## A.3 Proof of Proposition 3

The proof is similar to that of Proposition 1.

1. Figures C.1 to C.3 illustrate the possible equilibrium pooling contracts. $\hat{C}$ denotes the optimal contract for type $LN$ on the average pricing line $\bar{\mathbf{P}}$. In Figure C.1, the indifference curve of type $HR$ is flatter than $\bar{\mathbf{P}}$ at point $\hat{C}$. Thus, any contract $C'$ which is located in the region surrounded by curves $EU^*_{HR}$ and $EU^*_{LN}$ and line $\mathbf{P}_L$ attracts type $LN$ individuals and earns non-negative expected profits. Thus, $\hat{C}$ is not an equilibrium contract.

   In Figure C.2, the indifference curve of type $HR$ is steeper than $\bar{\mathbf{P}}$ at point $\hat{C}$. Thus, any contract $C'$ which is located in the region surrounded by curves $EU^*_{HR}$ and $EU^*_{LN}$ and the 45-degree line attracts type $LN$ individuals and earns non-negative expected profits. Thus, $\hat{C}$ is not an equilibrium contract.

In Figure C.3, the slope of the indifference curve of type $HR$ is the same as that of $\bar{\mathbf{P}}$ at point $\hat{C}$. Thus, any contract $C'$ which is located either in the region surrounded by curves $EU^*_{HR}$ and $EU^*_{LN}$ and line $\mathbf{P}_L$ or in the region surrounded by curves $EU^*_{HR}$ and $EU^*_{LN}$ and the 45-degree line attracts type $LN$ individuals and earns non-negative expected profits. Thus, $\hat{C}$ is not an equilibrium contract.

2. Figure 8 illustrates the equilibrium. For $I < L$, the indifference curve of type $LN$ individuals is flatter than the pricing line $\mathbf{P}_L$ since insurance rates are actuarially fair and $u$ is concave. That is,

$$\frac{1-p_L}{p_L}\frac{u'(w-p_L I)}{u'(w-L+(1-p_L)I)} \leq \frac{1-p_L}{p_L}. \tag{A.13}$$

Thus, contract $X = A_{LN}$ in this case. Let $B = (I_B, p_L)$, as shown in Figure 8, denote the contract at which type $HR$ is indifferent between this contract and $A_{HR}$. The condition $EU_{HR}(A_{HR}) \geq EU_{HR}(A_{LN})$ implies that the self-selection constraint for type $HR$ is satisfied. Since $A_{LN}$ is the optimal contract for type $LN$ at the premium rate $c = p_L$, it is also the optimal contract at any premium rate $c \geq p_L$. The self-selection constraint for type $LN$ is satisfied as well. Last, insurance companies cannot offer any contract which contains higher net coverage as the FBA in the loss state but is not chosen by either types of individuals.

3. The equilibrium is illustrated in Figure 9. Condition $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HR}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LN}(B)}}\right|$ is equivalent to the indifference curve type $HR$ being flatter than that of type $LN$ at point $B$, i.e.,

$$\begin{aligned} &\frac{1-p_H}{p_H}\frac{1+g'(u(w)-u(w-p_L I_B))}{1+g'(u(w-p_X L)-u'(w-L+(1-p_L)I_B))} \\ &\times\frac{u'(w-p_L I_B)}{u'(w-L+(1-p_L)I_B)} \\ < &\frac{1-p_L}{p_L}\frac{u'(w-p_L I_B)}{u'(w-L+(1-p_L)I_B)}, \end{aligned} \tag{A.14}$$

or, equivalently,

$$\frac{1-p_H}{p_H}\frac{1+g'(u(w)-u(w-p_L I_B))}{1+g'(u(w-p_X L)-u'(w-L+(1-p_L)I_B))} < \frac{1-p_L}{p_L}. \tag{A.15}$$

If the condition $EU_{HR}(A_{HR}) < EU_{HR}(A_{LN})$ and condition (A.15) hold and the proportion of type $HN$ is large enough, then, as shown in Figure 9, the self-selection constraints of both types are satisfied and there is no other profitable contract that is preferred only by type $LN$ individuals. It is also not possible to offer any other contract besides $X$ which contains higher net coverage as the FBA in the loss state but is not chosen by either types of individuals. Note that $X = (L, p_X)$ where $p_X < p_H$ is determined by $EU_{HR}(A_{HR}) = EU_{HR}(X)$.

## A.4 Proof of Proposition 4

1. The proof that no pooling equilibrium exists is analogue to the proof in Proposition 3.

2. Figure 10 illustrates the equilibrium. The condition $EU_{HR}(A_{HR}) \geq EU_{HR}(A_{LR})$ implies that the self-selection constraint for type $HR$ is satisfied. Since $A_{LN}$ is the optimal contract for type $LN$ at the premium rate $c = p_L$, it is also the optimal contract at any premium rate $c \geq p_L$. The self-selection constraint for type $LN$ is satisfied as well. Last, insurance companies cannot offer any contract which contains higher net coverage than $X$ offers in the loss state but is not chosen by either types of individuals.

3. Figure 11 illustrates the equilibrium. The condition $EU_{HR}(A_{HR}) < EU_{HR}(A_{LN})$ implies that the indifference curve of the type $LN$ is flatter than $\mathbf{P}_L$ at $B$, i.e.,

$$\frac{1-p_L}{p_L}\frac{u'(w-(1+\theta)p_L I_B)}{u'(w-L+(1-(1+\theta)p_L)I_B)} < \frac{1-(1+\theta)p_L}{(1+\theta)p_L}. \tag{A.16}$$

Condition $\left|\frac{dW_1}{dW_0}|_{\overline{EU_{HR}(B)}}\right| < \left|\frac{dW_1}{dW_0}|_{\overline{EU_{LN}(B)}}\right|$ is equivalent to

$$\begin{aligned} & \frac{1-p_H}{p_H}\frac{1+g'(u(w)-u(w-(1+\theta)p_L I_B))}{1+g'(u(w-p_L L)-u'(w-L+(1-(1+\theta)p_L)I_B))} \\ & \times\frac{u'(w-(1+\theta)p_L I_B)}{u'(w-L+(1-(1+\theta)p_L)I_B)} \\ < \; & \frac{1-p_L}{p_L}\frac{u'(w-(1+\theta)p_L I_B)}{u'(w-L+(1-(1+\theta)p_L)I_B)}, \end{aligned} \tag{A.17}$$

or

$$\frac{1-p_H}{p_H}\frac{1+g'(u(w)-u(w-(1+\theta)p_L I_B))}{1+g'(u(w-p_L L)-u'(w-L+(1-(1+\theta)p_L)I_B))} < \frac{1-p_L}{p_L}. \tag{A.18}$$

As shown in Figure 11, if the indifference curve of type $LN$ going through $B$ does not intersect $\bar{\mathbf{P}}$, then there does not exist any other contract that attracts type $LN$ and earns non-negative expected profits.

# A Appendix B: Figures

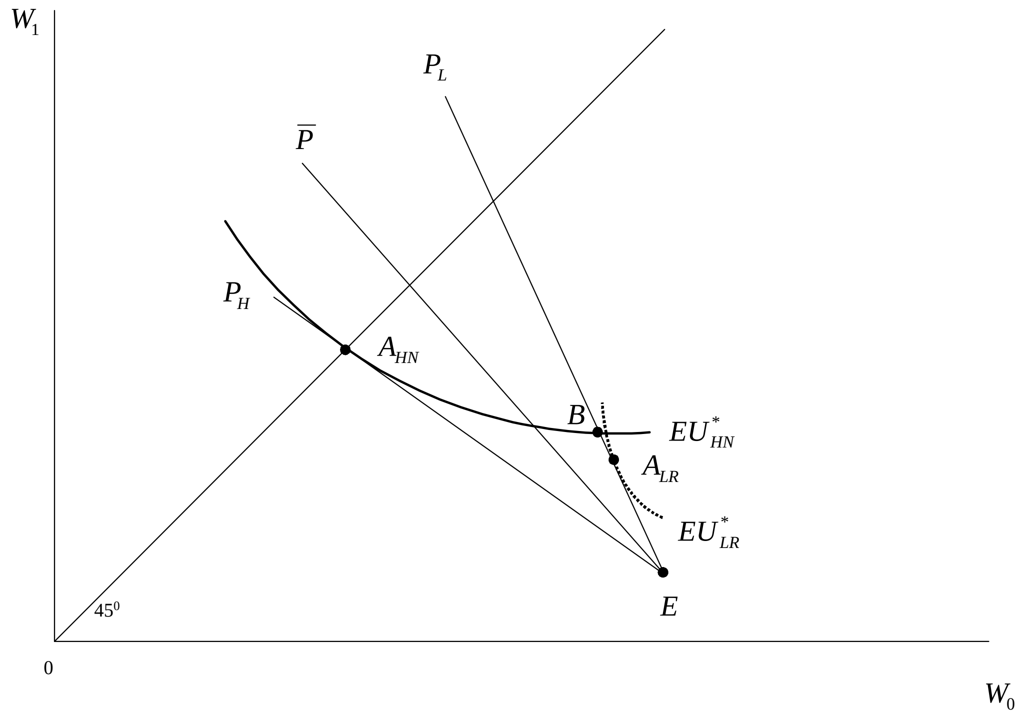


Figure 1: $HN$ and $LR$ types, actuarially fair rates: separating equilibrium with positive relation between insurance coverage and risk that coincides with the full information equilibrium.

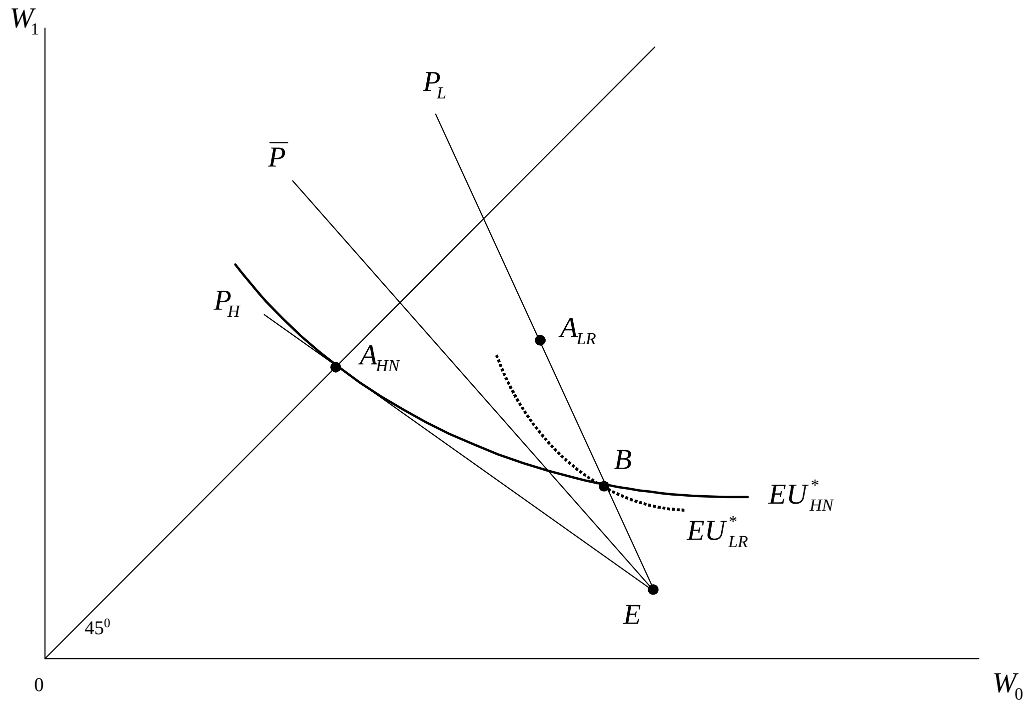


Figure 2: $HN$ and $LR$ types, actuarially fair rates: separating equilibrium with positive relation between insurance coverage and risk that does not coincide with the full information equilibrium.

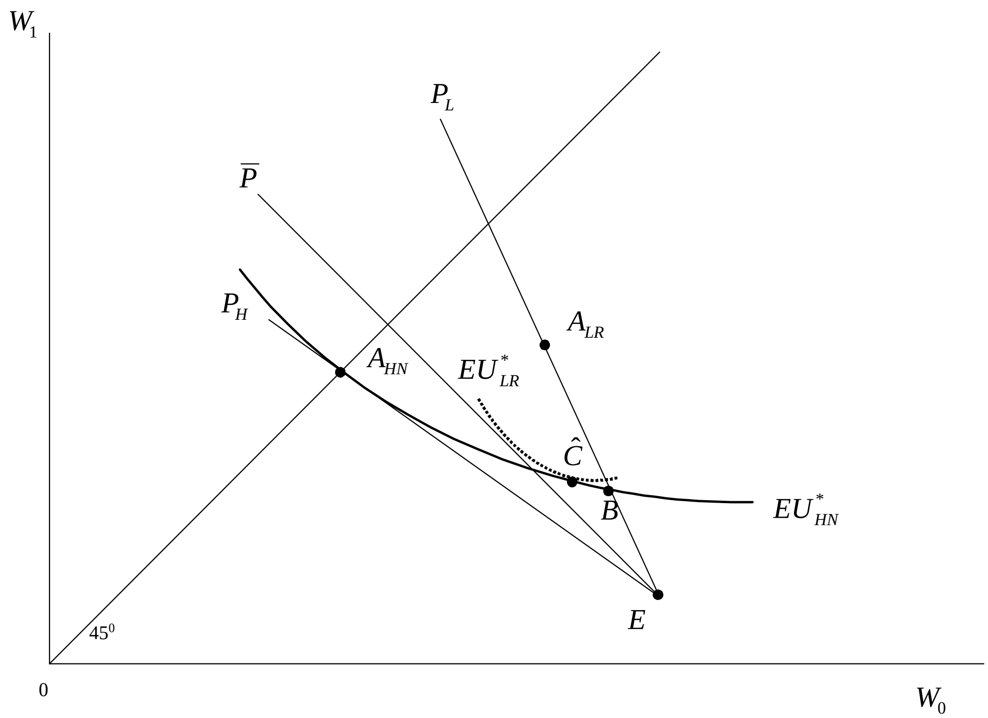


Figure 3: $HN$ and $LR$ types, actuarially fair rates: semi-pooling equilibrium with positive relation between insurance coverage and risk that does not coincide with the full information equilibrium.

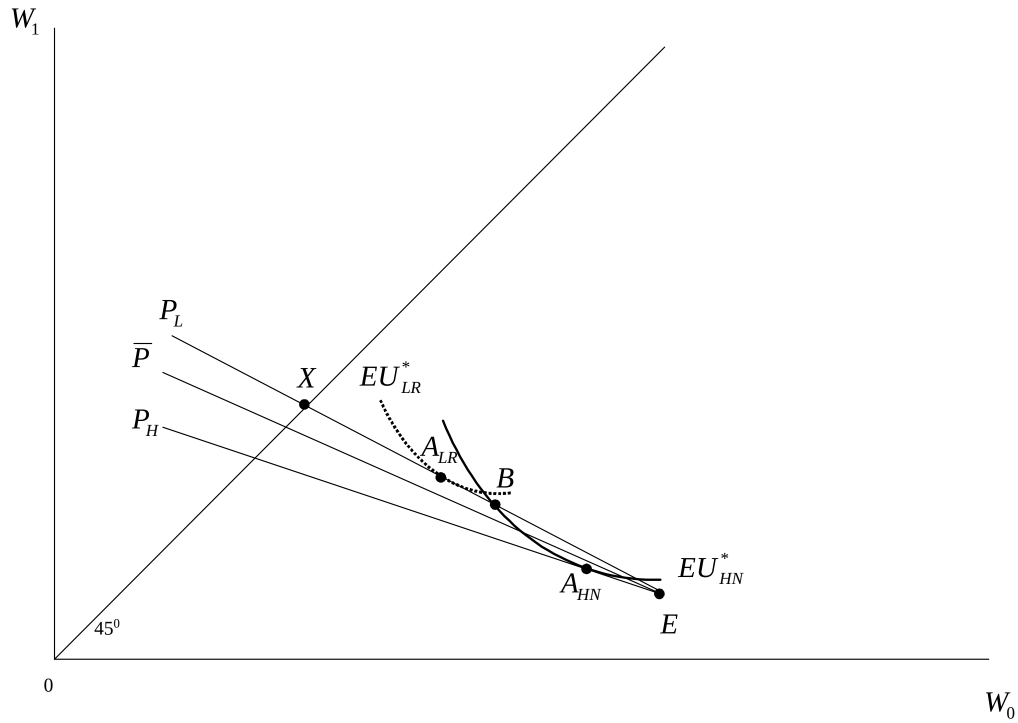


Figure 4: $HN$ and $LR$ types, high loading: separating equilibrium with negative relation between insurance coverage and risk that coincides with the full information equilibrium.

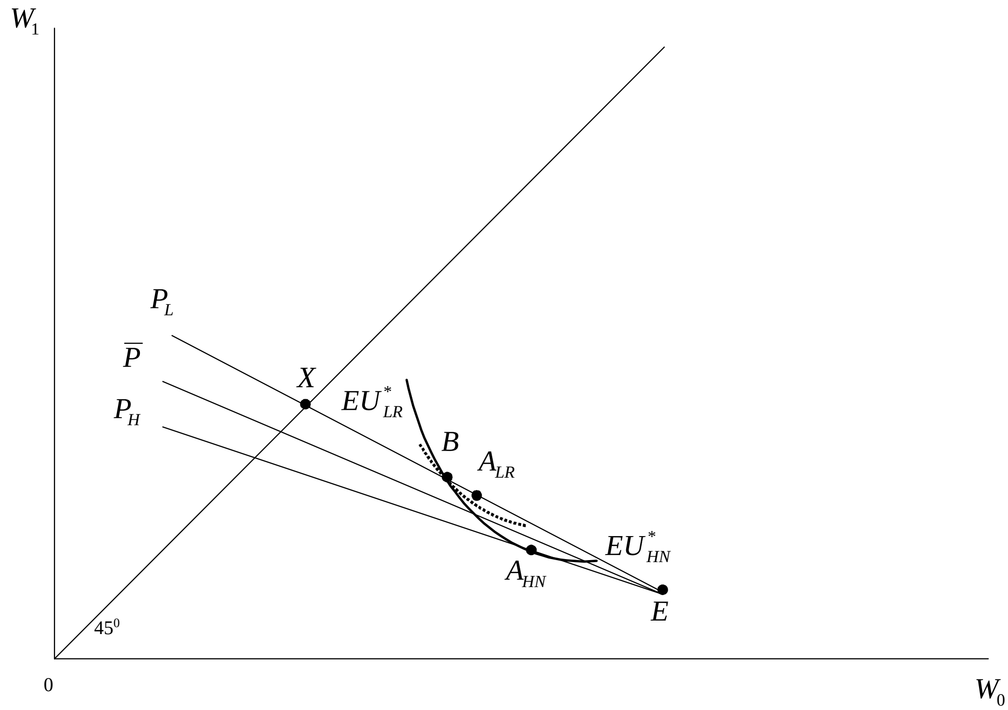


Figure 5: $HN$ and $LR$ types, high loading: separating equilibrium with negative relation between insurance coverage and risk type that does not coincide with the full information equilibrium.

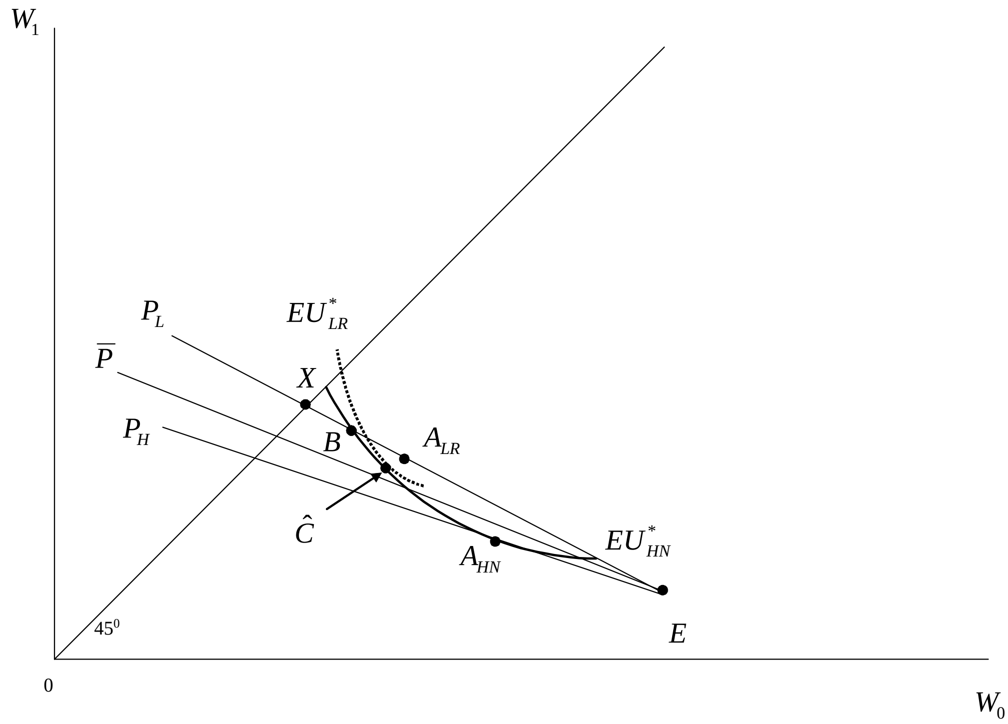


Figure 6: $HN$ and $LR$ types, high loading: semi-pooling equilibrium with negative relation between insurance coverage and risk type that does not coincide with the full information equilibrium.

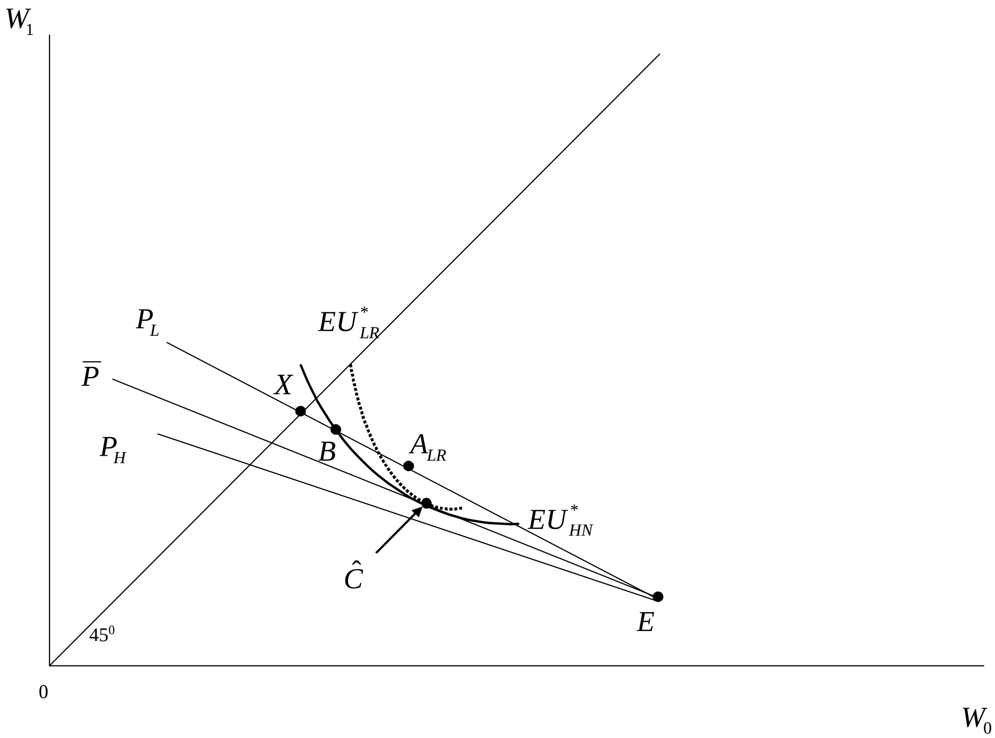


Figure 7: $HN$ and $LR$ types, high loading: pooling equilibrium.

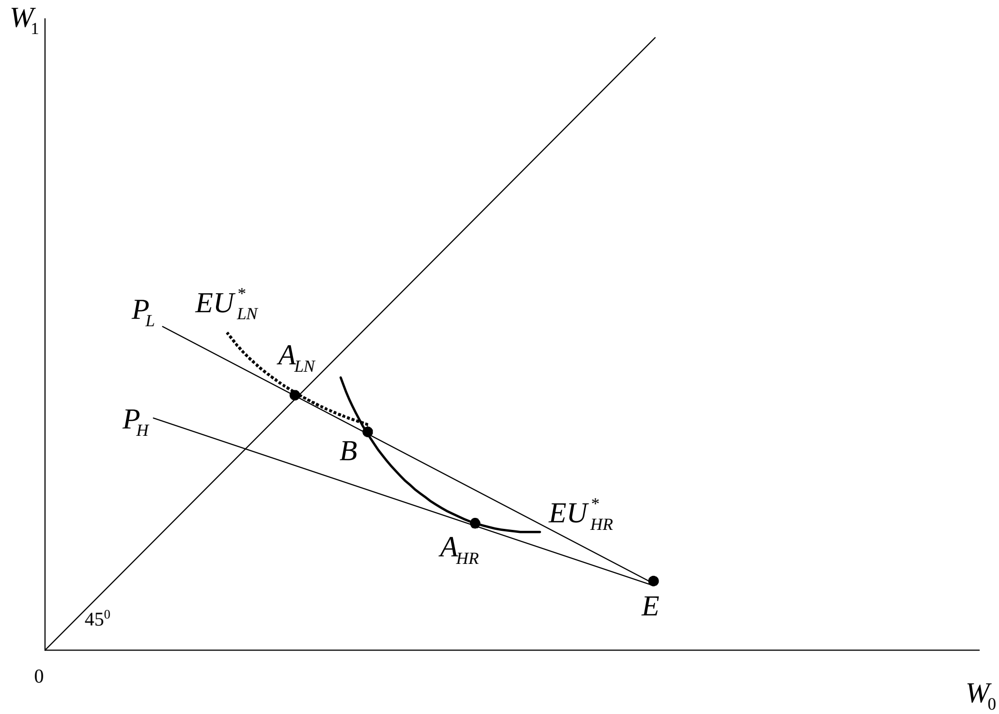


Figure 8: $HR$ and $LN$ types, actuarially fair rates: separating equilibrium with negative relation between insurance coverage and risk that coincides with the full information equilibrium.

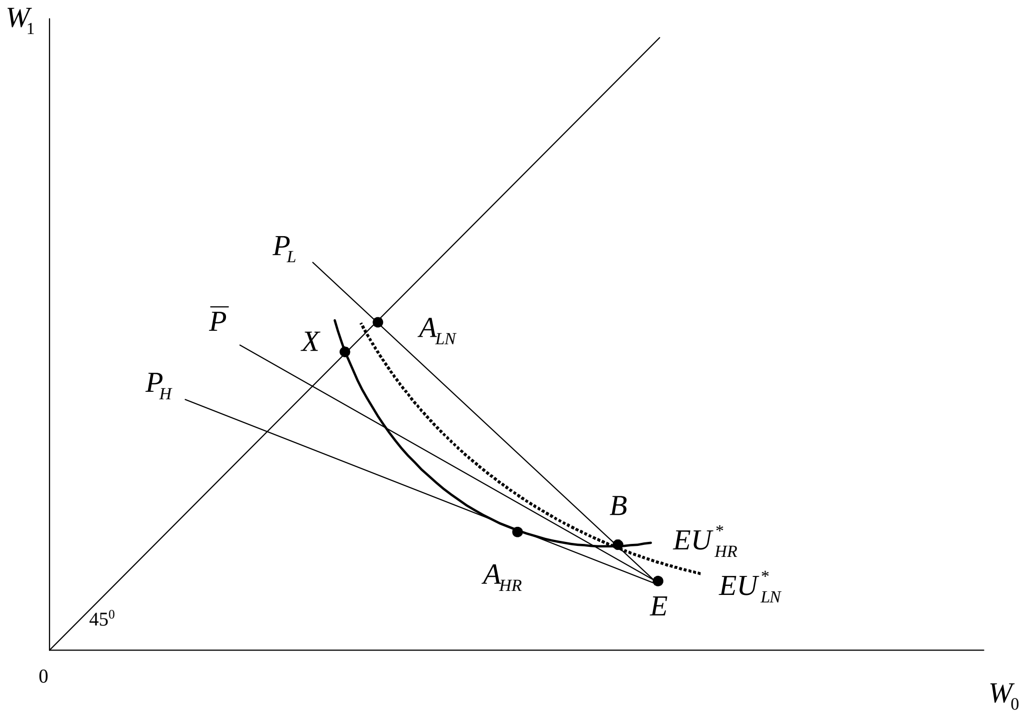


Figure 9: $HR$ and $LN$ types, actuarially fair rates: separating equilibrium with positive relation between insurance coverage and risk that does not coincide with the full information equilibrium.

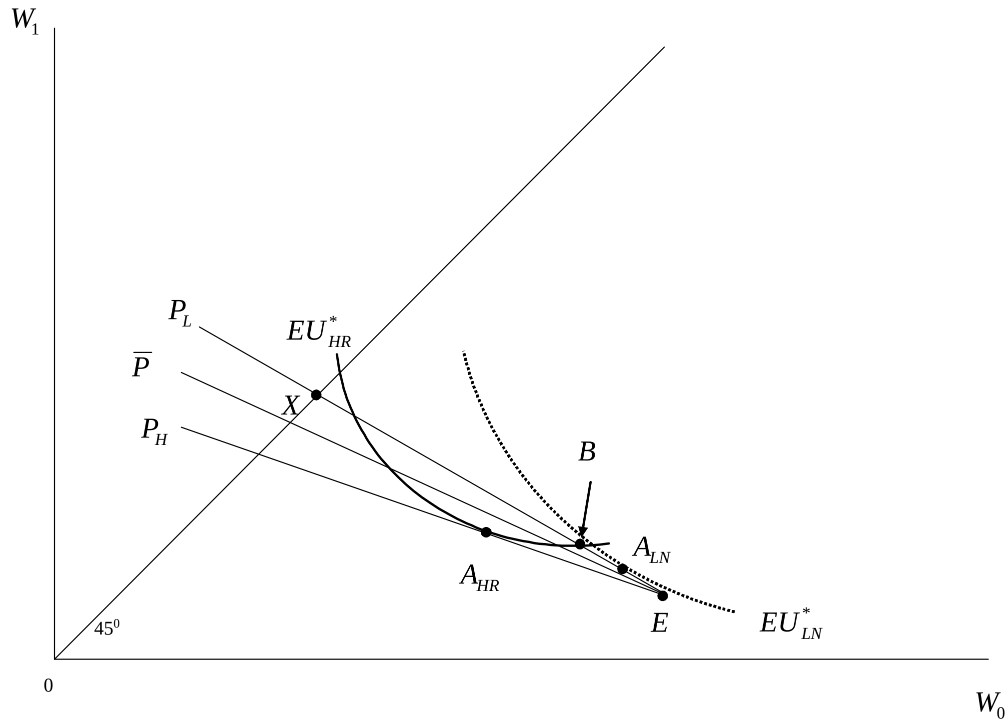


Figure 10: $HR$ and $LN$ types, high loading: separating equilibrium with positive relation between insurance coverage and risk that coincides with the full information equilibrium.

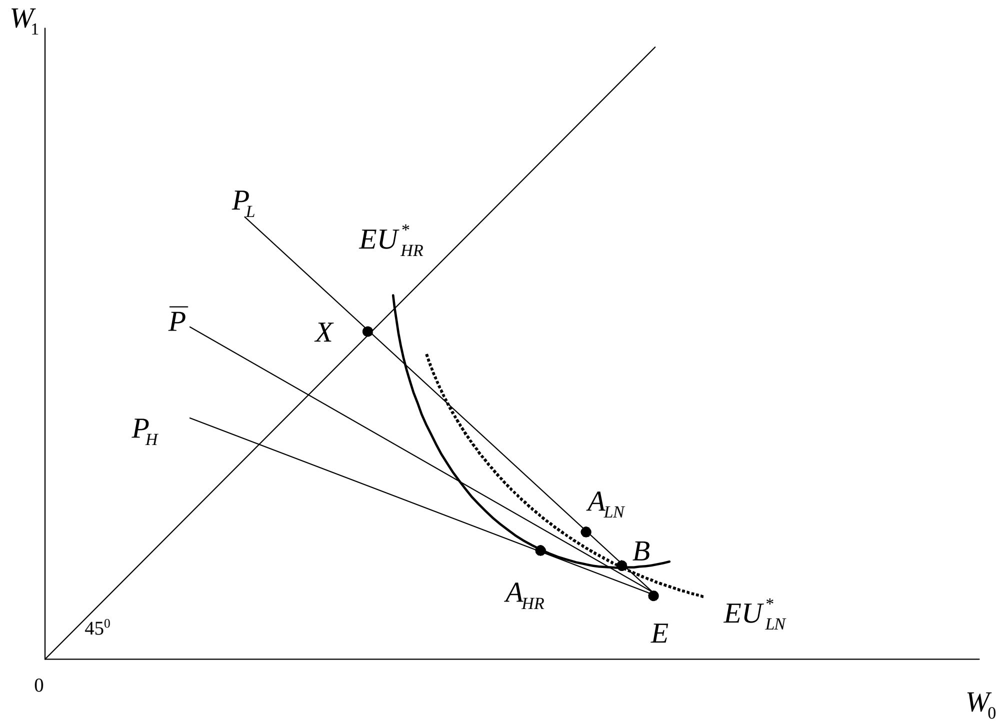


Figure 11: $HR$ and $LN$ types, high loading: separating equilibrium with positive relation between insurance coverage and risk that does not coincide with the full information equilibrium.

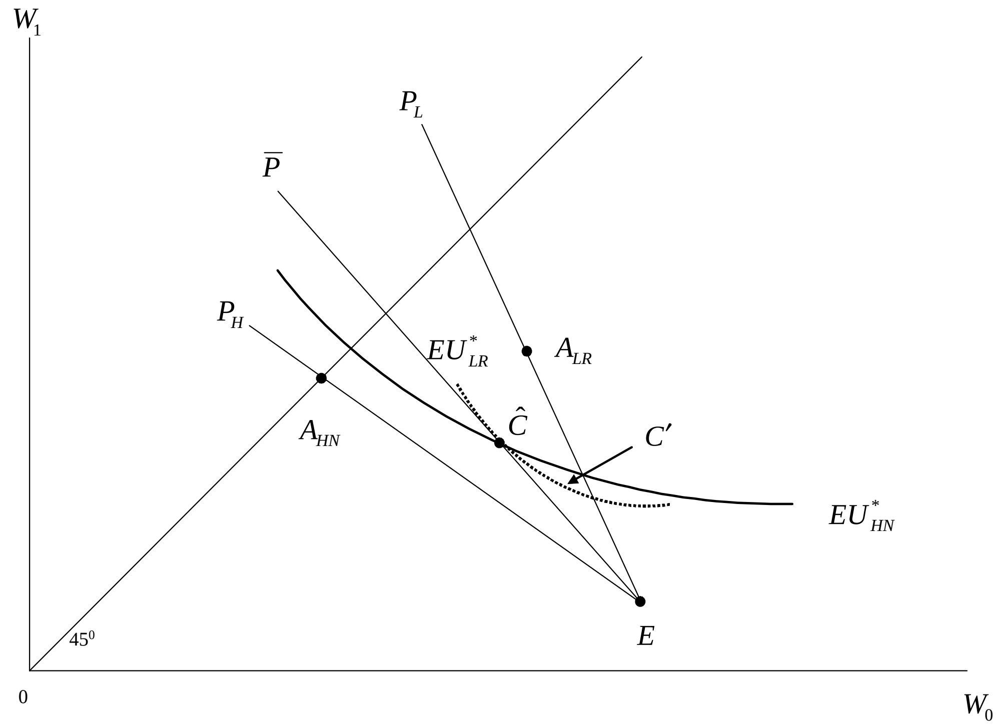


Figure A.1: $HN$ and $LR$ types: No pooling equilibrium if the indifference curve of $EU^*_{LR}$ is steeper than that of $EU^*_{HN}$ at contract $\hat{C}$.

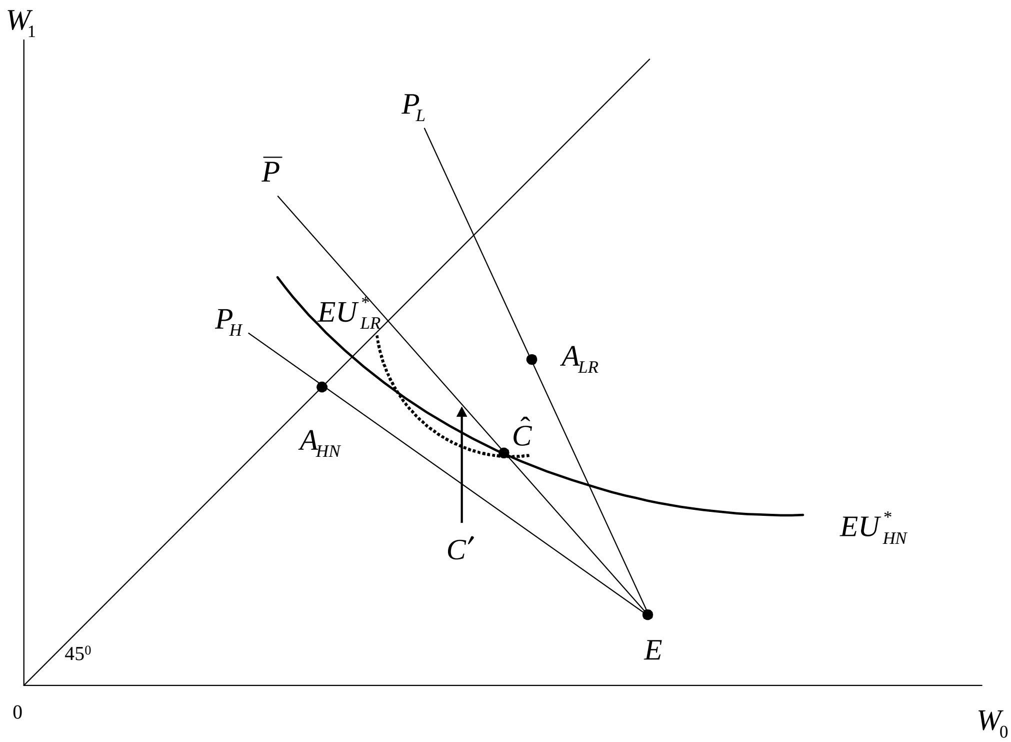


Figure A.2: $HN$ and $LR$ types: No pooling equilibrium if the indifference curve of $EU^*_{LR}$ is flatter than or tangent to that of $EU^*_{HN}$ at contract $\hat{C}$.

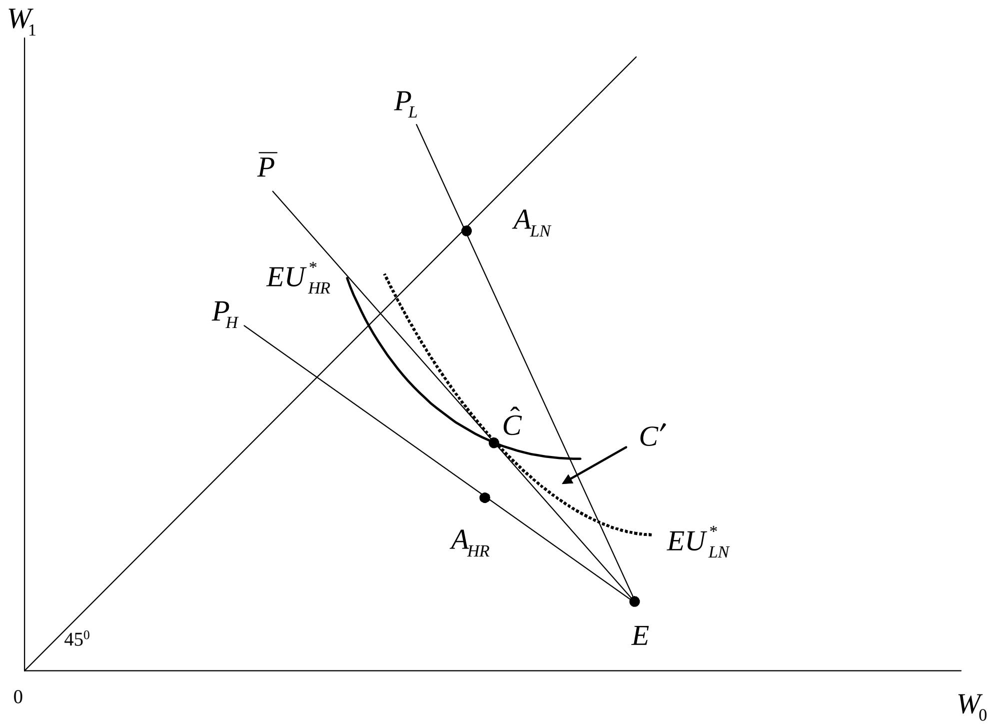


Figure C.1: $HN$ and $LR$ types: No pooling equilibrium if the indifference curve of $EU^*_{LN}$ is steeper than that of $EU^*_{HR}$ at contract $\hat{C}$.

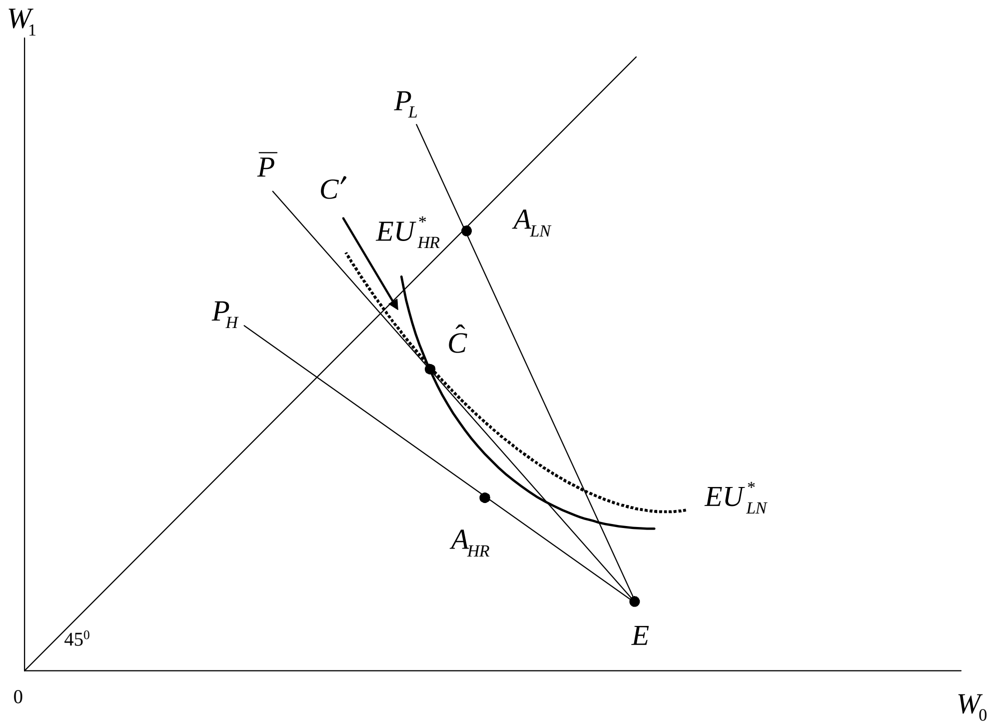


Figure C.2: $HN$ and $LR$ types: No pooling equilibrium if the indifference curve of $EU^*_{LN}$ is flatter than that of $EU^*_{HR}$ at contract $\hat{C}$.

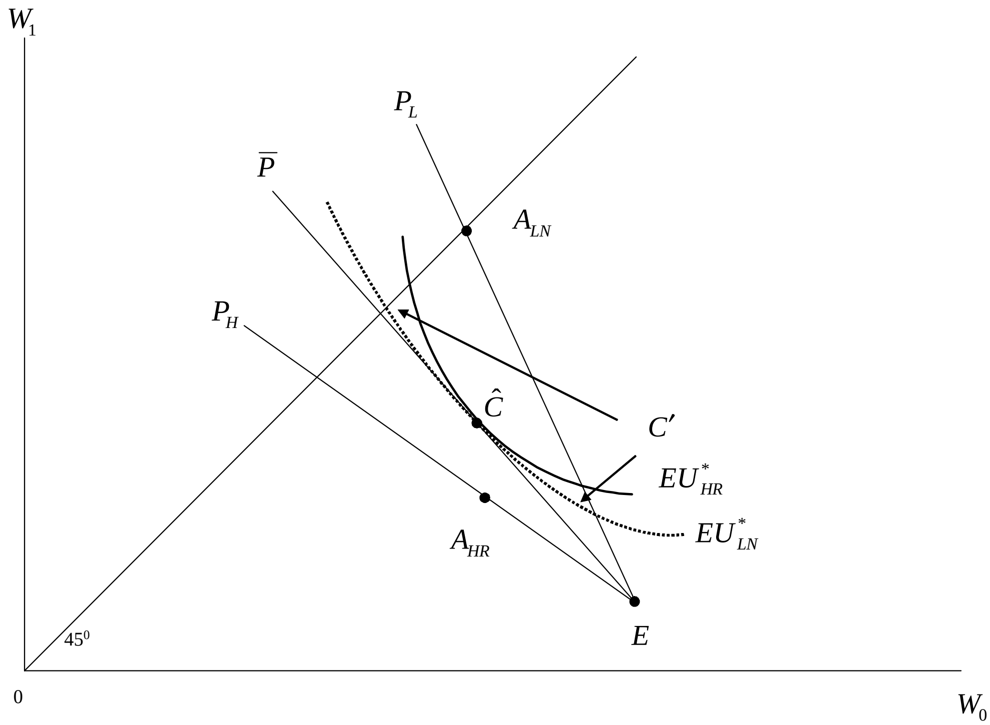


Figure C.3: $HN$ and $LR$ types: No pooling equilibrium if the indifference curve of $EU^*_{LN}$ is tangent to that of $EU^*_{HR}$ at contract $\hat{C}$.