Tracking Steps to Lower Your Premium

With the introduction of health insurance including financial incentives for customers who show 'healthy' behaviour in the Netherlands, concerns were raised regarding adverse selection and equity. In these concerns, the accessibility of the new type of insurance for different subsections of the population plays an important role. In this paper, I set up a theoretical model of the health insurance market to study how market power influences optimal health insurance with financial incentives for illness prevention. Using the model, I show that, if risk type is observable and individuals differ in income, all individuals remain insured under both perfect competition and monopoly. In addition, I show that, if risk type is unobservable, the observability of illness prevention can increase social welfare but cannot remove the inefficiencies of the unobservability of risk type completely. The insurer can utilize the observability of illness prevention by engaging in menu pricing. However, I show that this is only possible if individuals differ in their willingness to pay for insurance with effort rewards. Next to that, I find the preferences of individuals may not be aligned with the preferences of the insurer regarding illness prevention if the insurer is a monopolist. This can lead to a socially inefficient amount of effort being exerted.

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1. Introduction

Recently, Dutch health insurers have started to offer insurance that includes financial incentives for customers who show ‘healthy’ behaviour, such as how many footsteps you walk in a day (Bogosavac, 2021). For example, Dutch insurance company a.s.r. offers a yearly discount on the additional deductible next to weekly and monthly rewards to individuals who track their exercise (“Geld verdienen met sporten”, 2019). There are many advantages to such insurance. First, insurers might be able to target more consumers, as the rewards could make being insured more attractive to individuals who are insured elsewhere or not insured at all. In addition, due to differences in willingness to pay of individuals, such insurance may facilitate price discrimination for insurers. Second, the rewards could be helpful for governments to promote a healthy lifestyle and thus cut increasing health care costs through prevention of illness (Fries et al., 1993). Third, consumers could cut their expenditures on health insurance and receive an incentive to increase their quality of life. A healthier lifestyle could also lower their health expenditures in the long term.

While the demand for insurance with effort rewards is growing in the Netherlands, some insurance companies have stated they will not offer these rewards (“Geld verdienen met sporten”, 2019). The reasoning behind this has to do with adverse selection. Adverse selection occurs when individuals who expect high health care costs prefer relatively more generous and expensive insurance while individuals who expect low costs prefer more modest plans (Cutler & Zeckhauser, 1998). This can lead to three types of inefficiencies. First, for individuals, the prices do not reflect marginal costs. Then, individuals select the wrong insurance on a cost-benefit basis. Second, it would reduce risk spreading which is undesirable. Third, insurance companies could change their offers to attract only the unhealthy. Exerting effort reduces the probability of being ill and therefore is more attractive to unhealthy individuals. If only unhealthy individuals are insured, the expected costs of the insurer increase which will lead to a higher premium. Then, the insurance will attract a decreasing number of unhealthy individuals until only a small part of the population prefers purchasing insurance with a very high premium.

The previous concerns portray the importance of accessibility to insurance with financial incentives regarding price. On the one hand, if a monopolist offers such insurance with a high premium, it could be the case that only a part of the population can or wants to purchase insurance. On the other hand, in a market of perfect competition, the insurance contract is more likely to be affordable to the whole population. Then, the advantages of insurance with behavioural rewards could be socially optimal.

To study how market power influences optimal health insurance with financial incentives for illness prevention, I set up a theoretical model which portrays the health insurance market. Then, I compare the outcomes of the model in the situation of perfect competition with a monopolist. Ehrlich and Becker (1972) were the first to develop a theory of the demand for insurance that incorporates the possibility of 'self-protection'. The theory reveals the importance of whether illness prevention is observable to the insurer. If this is not the case, individuals do not have an incentive to invest in prevention when insured. In a situation with perfect information, Stiglitz (1983) shows the incentive problem disappears because prevention can be rewarded by the insurer. In addition, Zweifel, Breyer and Kifmann (2009) find individuals only engage in prevention, when observable to the insurer, if it increases their expected income.

This paper contributes to the previous academic literature in two ways. First, this is the first model of optimal health insurance with illness prevention to study the outcomes in a monopolist market to my knowledge. Previous literature focuses on fair insurance where the premium is actuarially fair, which is the case under perfect competition. Since health insurance markets worldwide are often (partially) privatised, studying the effect of market power is a very relevant addition to the literature. Second, previous models assumed illness prevention is most often unobservable to the insurer. Under the new type of contract with financial incentives, prevention can be tracked. Using this, I study the situation where the insurer needs to identify between different health risks of individuals. In the model, I show how the observability of effort can be utilized to engage in price discrimination which can potentially lead to an increase in social welfare.

The outcomes of the model relate to previous literature in the field of health insurance in the following ways. First, in line with Ehrlich and Becker (1972) and Stiglitz (1983), I find illness prevention is only attractive to the individual if it is observable to the insurer. Second, the outcomes of my model are consistent with the optimal prevention model in Zweifel et al. (2009). However, Zweifel et al. (2009) include the possibility of partial insurance, whereas individuals in my model choose between either being fully insured or uninsured. Zweifel et al. (2009) find a second-best solution through using coinsurance. In the model, I show there are certain situations where engaging in menu pricing based on the illness prevention preferences of individuals is attractive to insurers. Once again, this depends on whether effort is observable to the insurer.

First, in section 2, I will discuss the theory behind the demand for health care and the demand for health insurance. Then, I will highlight the previous literature in the field of optimal health insurance. In addition, I set up a basic model of health insurance based on Cutler and Zeckhauser (2000) and show why, in the absence of moral hazard, individuals prefer insurance with a fair premium above not being insured. Next, I explain the theory regarding moral hazard and review the literature of three methods that provide incentives to individuals which can avoid moral hazard: coinsurance, deductibles and preventive care incentives. After discussing the theory behind illness prevention, I also review empirical literature where the effects of health insurance on prevention is estimated.

Second, in section 3, I add illness prevention to the basic model set up in section 2.3.1.1. Next, I compare the situations for which an individual prefers being insured with and without rewards for illness prevention. Afterwards, I portray the model in the situation with a monopolist and compare the outcomes with the outcomes of the basic model under perfect competition. Subsequently, I study the situation where individuals differ in income and compare the situations under perfect competition and a monopolist. I show that, if risk type is observable and individuals differ in income, all individuals remain insured under both perfect competition and monopoly. Thereafter, I consider a situation where the insurer cannot observe the risk probabilities of individuals which leads to moral hazard. I show that, if risk type is unobservable, the observability of illness prevention can increase social welfare but cannot remove the inefficiencies of the unobservability of risk type completely. The insurer can utilize the observability of illness prevention by engaging in menu pricing. However, I show that this is only possible if individuals differ in their willingness to pay for insurance with effort rewards. In addition, I show that, due to an increase in market power, the preferences of individuals may not be aligned with the preferences of the insurer regarding illness prevention which can lead to a socially inefficient amount of effort being exerted.

Third, in section 4, I discuss the assumptions of the model and make a few suggestions of how the model could be improved for future research.

Finally, in section 5, I summarize the main results. Next, I consider the policy implications of the outcomes of the model and put forward recommendations for future research on the topic of illness prevention.

2. Theoretical background

In the following section, I will discuss the theory behind the demand for health care, the demand for health insurance and optimal health insurance. In addition, I explain the theory regarding moral hazard and review the literature of three methods that provide incentives to individuals which deter moral hazard: coinsurance, deductibles and preventive care incentives.

2.1. Demand for health care

From an economic perspective, health is a durable good or type of capital that provides services (Grossman, 1972). Grossman (1972) sets up a model to study the demand for health care where each individual has a certain stock of health at the beginning of a period. Over the period, health depreciates with age but can also be expanded with investments into medical services. When an individual's stock of health reaches a critical minimum level, the person does not survive the period.

Health provides services that yield utility (Santerre & Neun, 2012). Health is demanded for both consumption and investment purposes. From a consumption perspective, an individual desires to remain healthy because of the utility received from an improvement in quality of life. In addition, an individual invests in health to be able to generate income during a longer period. This income can be used in the future when an individual might be less healthy. Individuals select their consumption bundle, which includes the services produced from the stock of health, to maximize utility. The relationship between the stock of health and utility is derived from the law of diminishing marginal utility. An increase in the stock will increase utility. However, the increase in utility will be decreasing for each successive increase in the stock of health.

Medical care is the combination of goods and services which maintain, improve or restore the health of an individual (Santerre & Neun, 2012). Thus, medical care influences an individual's stock of health. Therefore, through the stock of health, medical care expenditures affect utility. The individual will consume medical care up to the point where the increase in utility due to an extra unit of medical care is equal to the marginal cost of consuming that extra unit. The problem individuals face is the uncertainty in how much they would optimally like to spend on medical services. While individuals do have some knowledge about their need for medical care, there remains a large degree of uncertainty in the exact amount they will spend in future periods (Cutler & Zeckhauser, 2000). The value of health insurance is rooted in this uncertainty.

2.2. Demand for health insurance

The motivation behind health insurance is to spread the risk of considerable medical expenditures (Zeckhauser, 1970). The demand for insurance reflects the maximum an individual would pay above the expected loss of an accident to avoid the consequences of that accident (Friedman & Savage, 1948; Ehrlich & Becker, 1972). In terms of health insurance, suppose an individual has a certain probability of having a heart attack. The expected loss is the medical costs associated with a heart attack times the probability of a heart attack happening. The individual would demand insurance if the individual would be willing to pay more than the expected loss to avoid the cost-related consequences of a heart attack. If individuals are risk-averse, they are willing to pay more for the certain outcome of insurance than the uncertain outcome of being uninsured (Morrisey, 2008). In other words, an individual is risk-averse if the loss of 1 euro decreases utility more than the gain of 1 euro increases utility. This is exactly what the law of diminishing marginal utility states.

The maximum an individual is willing to pay for insurance depends on their degree of risk aversion, the expected loss of the accident, the probability of that accident happening and the individual's wealth position (Morrisey, 2008). First, individuals differ in their degree of risk aversion. An individual with a high degree of risk aversion will be willing to pay more for insurance and have a higher probability to purchase insurance, ceteris paribus, compared to an individual with a low degree of risk aversion. This is because the expected loss of the uncertainty in terms of utility is higher for the individual with a high degree of risk aversion. Second, as the size of the expected loss increases, individuals are willing to pay more for the premium. Then, individuals are more likely to purchase insurance. Third, as the probability of the loss increases, the size of the premium first increases but declines afterwards. Thus, the probability of purchasing insurance first increases but then declines. The intuition behind this is that for very small probabilities of an accident happening, the expected loss is very small and the risk premium is even smaller. As the probability increases, insurance becomes more attractive up to a certain maximum probability. After the maximum, the probability that an accident happens is so large, that the insurance does not take away a lot of uncertainty and therefore becomes less attractive again. However, individuals might still purchase the insurance if they know that the probability of an accident is high, whereas the insurer does not. Finally, for an individual with more wealth, the risk premium will be lower compared to an individual with less wealth. Therefore, the individual with more wealth will be less likely to purchase insurance. A wealthier person will be more able to 'self-insure', in which case the individual does not need to pay the premium to the insurer. However, for example in the United States, wealthier individuals purchase more health insurance (Morrisey, 2008). First, this contradiction can be explained by the fact that the model does not include the role of employers and employer-sponsored health insurance. In the United States, employer-sponsored insurance had a tax-exempt status and therefore is more attractive to high-income individuals, as they pay the most taxes. In addition, the model only studies the willingness to pay of individuals and not whether all individuals can afford insurance. In reality, low-income Americans might not be able to afford health insurance in a partially privatised health insurance market.

Nyman (1999) provides another reason, next to risk aversion, why people demand health insurance which is called the access motive. Nyman (1999) argues there is no financial risk for unaffordable health care expenditures because privately the expenditure cannot occur. Health insurance represents a mechanism that gives individuals access to health care that they otherwise could not afford.

If only health insurance provides access to expensive health care, then insurance is valued as the expected consumer surplus which the otherwise inaccessible health care services provide.

2.3. Optimal health insurance

As the demand for health insurance is present, what is the optimal health insurance for individuals? To describe the optimal insurance, I first need to make a distinction between insurance with or without the presence of moral hazard. Moral hazard takes place when insured individuals overuse medical services because from the individual's perspective the services appear to be free or heavily subsidized (Eggleston, 2000). I will come back to this later and first describe optimal insurance in the absence of moral hazard.

2.3.1. Optimal health insurance without moral hazard

The optimal insurance contract would only pay out the exact amount that the individual would have spent, had the individual not been insured (Cutler & Zeckhauser, 2000). In the absence of moral hazard, medical costs resulting from illness must be randomly distributed across the population (Zweifel et al., 2009). Individuals cannot influence their probability of becoming ill through prevention or limit their medical costs in the case of illness. It is very unlikely these strict assumptions hold in reality. However, describing the outcome of this simple model provides a point of reference for models incorporating moral hazard.

2.3.1.1. The basic insurance model without effort

The most basic insurance model is one where illness entails a fixed cost and the insurer competes on a perfectly competitive market (Cutler & Zeckhauser, 2000). An individual is either ill or healthy. People are healthy ($h = 1$) with probability $1 - p$. People are ill ($h = 0$) with probability p. Treatment of an ill person requires medical spending m. I assume that medical spending restores a person to perfect health.

Individuals receive utility u, which depends on their consumption x. Thus, $u = U(x)$. Individuals have income y. Then, an individual's consumption is what remains of y after medical expenditures m or the insurance premium π.

For uninsured people: $x = y$ when healthy and $x = y - m$ when ill.
For insured people: $x = y - \pi$.

I use subscripts I and N to indicate whether the individual is insured or uninsured. In addition, I use subscript pc to denote that the insurer competes in a perfectly competitive market.

In the absence of insurance, an individual's expected utility is given by:

$$V_{N,pc} = (1-p)U(y) + pU(y-m) \tag{1}$$

I assume U has the standard property that utility is increasing in consumption, but at a declining rate: $U' > 0$ and $U'' < 0$. I also assume that medical expenditures are worthwhile even if the individual is uninsured.

Suppose the individual purchases insurance against the risk of being ill. For an insurance company to break even, the fair insurance premium equals:

$$\pi_{pc} = pm \tag{2}$$

The insurance company pays out m when the individual is ill. If an individual selects insurance, the utility function will always be:

$$V_{I,pc} = U\left(y - \pi_{pc}\right) \tag{3}$$

Using a Taylor series expansion, I can rewrite $V_{N,pc}$ as:

$$V_{N,pc} \approx U\left(y - \pi_{pc}\right) + U'\left(\frac{U''}{2U'}\right)\pi_{pc}\left(m - \pi_{pc}\right) \tag{4}$$

Using the Taylor series expansion, I can calculate the value of insurance compared to being uninsured for an individual:

$$\frac{\left(V_{I,pc} - V_{N,pc}\right)}{U'} = \left(\frac{1}{2}\right)\left(\frac{-U''}{U'}\right)\pi_{pc}\left(m - \pi_{pc}\right) \tag{5}$$

The left-hand side of equation 5 is the difference in utility from being uninsured relative to being insured, scaled by marginal utility to give a dollar value for removing risk. The right-hand side is the benefit of risk removal. $\left(\frac{-U''}{U'}\right)$ is the coefficient of absolute risk aversion. This shows the degree to which uncertainty about marginal utility makes a person worse off. Since $U' > 0$ and $U'' < 0$, this term is positive. The term $\pi_{pc}\left(m - \pi_{pc}\right)$ represents the extent to which after-medical expenditure income varies because the person is uninsured. This term is also positive, implying the right-hand side of equation 5 is positive. Therefore, fair insurance is preferred to being uninsured. The dollar value of risk spreading increases with risk aversion and with the variability of medical spending.

2.3.2. Optimal insurance with moral hazard

Moral hazard occurs when individuals do not face the full cost of medical care and therefore demand treatment inefficiently (Albert Ma & Riordan, 2002). Consequently, the cost of treatment is sometimes greater than the benefit. In the optimal health insurance literature, a distinction is made between ex ante moral hazard and ex post moral hazard. Ex ante moral hazard refers to the situation before illness and entails a change in incentives for illness prevention due to health insurance (Ehrlich & Becker, 1972; Zweifel & Manning, 2000). Ex post moral hazard takes place once a health shock has occurred and entails an increase in the demand for medical care due to a lower price for the individual. In this paper, I will focus on ex ante moral hazard since illness prevention is the centre of attention in this paper.

Arrow (1963) was one of the first to describe the issue of moral hazard. He argues it is impossible to make insurance policies that can distinguish between risks. In particular, the insurer is unable to distinguish between avoidable and unavoidable risks. Then, incentives to avoid illness are weakened. Moral hazard is a problem because it conflicts with risk spreading (Cutler & Zeckhauser, 2000). Health insurance allows individuals to transfer their income to where they need it most. However, with the presence of moral hazard, this transfer is not perfect. This leads to an efficiency loss. Individuals increase their consumption of medical care when the insurer pays for most of it. Therefore, the insurer faces a trade-off: making the insurance more generous increases risk spreading but also leads to a larger presence of moral hazard.

In contrast, De Meza (1983) argues the efficiency costs associated with health insurance which are attributed to moral hazard may be overestimated. In line with the access motive described by Nyman (1999), insurance permits income to be transferred across different states of the world. Therefore, the potential demand for health services can be transformed into effective demand. For example, most individuals would not be able to afford an expensive cancer treatment in the absence of insurance. However, with insurance being available, many individuals would sign the contract. Then, if an individual gets cancer and the insurer were to offer a choice between the treatment and a lump-sum transfer equal to the treatment costs, the treatment option would often be preferred. In that case, there are no efficiency costs associated with the increase in demand. Similarly, Nyman (2008) describes an additional income effect of health insurance. The effect occurs due to the transfer of income from the healthy to the ill. Nyman (2008) argues it is mainly the ill who respond to the lower price of medical care after being insured. Few individuals will opt for an expensive heart operation if they are perfectly healthy. Thus, income is transferred from the healthy to the ill through a lower health care price due to insurance. Consequently, additional medical care is purchased which generates a welfare gain. The welfare gain can be large since insurance allows ill individuals to access health services which would have been far too expensive in the absence of insurance.

2.4. Financial incentives to deter moral hazard

Health care market insurers can provide individuals with incentives to avoid overspending. In this subsection, I will focus on three main methods which provide incentives: coinsurance, deductibles and preventive care incentives.

2.4.1. Coinsurance

One of the simplest methods to provide consumers with an incentive to not overconsume health services when insured is to introduce a coinsurance rate. Coinsurance is a policy tool aimed at the trade-off between risk spreading and moral hazard (Eggleston, 2000). The insurer uses the individual's medical expenditures as a signal of the medical treatment the individual truly needs (Cutler & Zeckhauser, 2000). A coinsurance rate creates the costs which are necessary to ensure the signalling works as intended. Coinsurance increases the price of health services for individuals after being insured. The optimal coinsurance rate is the percentage for which the utility gain to the individual of an additional small fraction of coverage equals the utility loss of paying for the excess health services (Pauly, 1968). Therefore, the optimal rate depends on the individual demand curve.

In the case of unobservable health, coinsurance is a second-best solution (Zweifel et al., 2009). The optimal coinsurance requires the insured to pay the full marginal cost of medical services. Then, the benefits should depend on the individual's health status and not on health expenditures. Since health status is unobservable to the insurer, the optimal situation is not obtained.

Zweifel et al. (2009) find the second-best solution using a linear coinsurance rate. In contrast, Drèze and Schokkaert (2013) and Manning, Newhouse, Duan, Keeler and Leibowitz (1987) argue a linear coinsurance rate is suboptimal compared to a non-linear rate, despite the convenience of a linear rate for comparative statics analyses. Insurance should be more generous for expensive medical services because the utility gain of additional coverage will be large for individuals taking risk aversion into account. For the small minority that suffers from severe medical problems which require expensive interventions, even a moderately high rate could lead to an enormous financial burden (Blomqvist, 1997). Thus, linear coinsurance could decrease the accessibility of insurance. Then, the insurer remains with the same trade-off between risk spreading and moral hazard.

2.4.2. Deductibles

Next to coinsurance, deductibles are often a part of health insurance contracts. A deductible is a yearly specified limit of health care expenditures which the individual must pay before the insurer provides reimbursement (Santerre & Neun, 2012). This policy tool likely has a negative effect on health care demand. However, this depends on factors such as the cost of treatment, the timing of illness and the expectations about future illnesses in the same period. With an increase in the deductible, an individual is less likely to satisfy the limit and thus more likely to act as if the individual is paying the full price for medical services (Morrisey, 2008). Zweifel et al. (2009) find the optimal deductible is positive if marginal loading is positive. Loading is the part of the insurance premium that is added in excess of the expected benefits paid out (Santerre & Neun, 2012).

Bardey and Lesur (2005) argue the optimality of a deductible does not extend to the health care sector. For small diseases, a deductible may be optimal. On the contrary, for severe diseases, full coverage is optimal. Even if individuals are fully insured, they have an incentive to reduce the risk of being ill because illness leads to a loss of utility. In the case of severe diseases, a deductible might even lower the incentives of taking preventive actions because the marginal costs of doing so increase. Therefore, Bardey and Lesur (2005) reason the presence of a deductible should depend on the severity of illness. In line with this finding, Drèze and Schokkaert (2013) explain it is better to insure medical expenditures when an individual's disposable income is lower compared to when it is high. Thus, expenditures via insurance should optimally be spent on the medical services with the highest costs.

Next to that, deductibles can lower the administrative costs of insurers (Santerre & Neun, 2012). Small claims are less likely to be made compared to a situation with full insurance because the claims have a smaller chance of being reimbursed. The insurer is relieved from processing small claims (Zweifel et al., 2009). The timing of illness throughout the year plays an important role here. For individuals, the price of medical services differs throughout the year (Buchanan, Keeler, Rolph & Holmer, 1991). If an individual has nearly paid the full limit halfway through the year, the price of the next expenditure will be perceived as free which leads to more demand.

2.4.3. Rewarding illness prevention

The method the model in this paper will focus on is financial incentives through illness prevention. I will concentrate on primary prevention, which is the prevention of illness from happening altogether, for example preventing illness by living a healthy lifestyle (Ellis & Manning, 2007). Health insurance has two offsetting effects on illness prevention which depend on whether the prevention is observable to the insurer (Ehrlich & Becker, 1972). On the one hand, prevention is discouraged because the marginal gain is smaller since insurance leads to a reduced difference in income and utility in different health states. On the other hand, prevention is encouraged if the premium is negatively related to prevention through the decrease in the probability of being ill. Insurers will only reward prevention if it is observable to them.

In a perfect situation with symmetric information between the insurer and consumers, there is no incentive problem (Stiglitz, 1983). The insurance contract would specify all possible situations, so individuals do not have an incentive to consume more health services than if they were uninsured. Assuming illness prevention reduces the probability of illness, a contract that requires individuals to exert effort to avoid illness would have premiums that then reflect the reduced probability of illness. Thus, individuals would be rewarded for their efforts. In reality, this perfect situation is very unlikely. Still, with asymmetric information, better incentives can be produced by using contracts that specify different situations more clearly (Marshall, 1976). Such contracts will not have a large impact on risk spreading. However, it can be costly for the insurer to write many contracts.

Ellis and Manning (2007) study optimal health insurance where prevention is unobservable. In their model, prevention and treatment are covered separately. An important finding is that the privately optimal coinsurance rate differs from the socially optimal rate. This is because individuals ignore the effect of prevention on the premium offered by the insurer. Therefore, insuring prevention can only be second-best optimal. Ellis and Manning (2007) also find different optimal coinsurance rates for prevention and treatment.

Zweifel et al. (2009) set up a model to find both optimal insurance coverage and the optimal level of prevention in three situations: without the possibility of insurance, with fair insurance and observable prevention and with fair insurance and unobservable prevention. First, without insurance, prevention can provide more utility for the larger effectiveness of prevention in lowering the probability of illness. Next to that, prevention can provide a larger expected utility loss of illness and a smaller expected utility loss caused by the costs of prevention which reduce income in all health states. Second, with fair insurance and observable prevention, individuals only engage in prevention if doing so increases expected income. In addition, full coverage is optimal since it keeps income equal across all health states. Third, with fair insurance and unobservable prevention, a potentially optimal insurance contract creates incentives for prevention through a coinsurance rate. However, this is a second-best solution since the expected utility of individuals will always be lower compared to the situation with observable prevention.

During the information exchange between the insurer and consumer, an important factor for the optimal level of prevention is whether the amount of insurance individuals purchase from other firms is observable to the insurer (Stiglitz, 1983). This is because an individual's behaviour depends on the total amount of insurance purchased. If an individual purchases extra insurance from a second company, the individual will take less care overall, leading to lower profits for the first company. In addition, Zweifel et al. (2009) find that the second-best solution under fair insurance with unobservable prevention described in the previous paragraph may not be reached if individuals can purchase insurance from multiple insurers. Individuals optimally choose full insurance with zero prevention. Expected utility is even lower compared to the second-best solution, making this a third-best solution.

Empirically, it is difficult to study the effects of health insurance on prevention because insurance is often self-selected and therefore not exogenous (Zweifel et al., 2009). Roddy, Wallen and Meyers (1986) study the effect of a change in health insurance plans on preventive care for American mine workers. Decreases in preventive visits compared to the period before the health plan change are found in both a period with coinsurance and a period with a copayment. Preventive visits decreased by 25 per cent with coinsurance and by 28 per cent with a copayment. Qin and Lu (2014) find a publicly subsidised health insurance plan has a significant effect on the tendency of individuals towards smoking, heavy drinking, sedentary activities, high-calorie foods and being overweight. The results are found using an instrumental variable addressing the endogeneity issue mentioned above. Yilma, van Kempen and de Hoop (2012) investigate whether being enrolled in the Ghanaian National Health Insurance Scheme affects the ownership and usage of bed nets that ward off mosquitos and thus offer protection against malaria. The results show insured households are less likely to sleep under a bed net compared to uninsured households. Stanciole (2008) compares U.S. households with and without insurance and finds significant effects on lifestyle behaviour. Health insurance increases the tendency towards heavy smoking, lack of exercise and obesity but decreases the tendency towards heavy drinking. De Preux (2011) study the effect of Medicare on prevention by comparing elderly individuals who were previously insured before Medicare to the elderly who were uninsured beforehand. No clear effect is found, also controlling for an anticipation effect, on alcohol consumption or smoking behaviour. However, a significant decrease is found in physical activity just before the elderly received Medicare.

Dave and Kaestner (2009) find an explanation for why empirical evidence of ex ante moral hazard is often found in other situations, such as employee and car insurance, but not in health insurance. Health insurance leads to changes in unobservable incentives through two channels (Dave & Kaestner, 2009). First, direct incentives related to prevention and behavioural effects, which is ex ante moral hazard. Second, indirect incentives related to changes in usage of medical services such as an increase in physician visits. These effects could be offsetting, leading to no or even a positive effect of health insurance on prevention in previous empirical research. Dave and Kaestner (2009) separate the effects by controlling for physician visits and study the effect of Medicare on the behaviour of elderly individuals using the same methodology as De Preux (2011). The results show that Medicare was associated with an increase in unhealthy behaviour. Among elderly males, Dave and Kaestner (2009) find significant ex ante moral hazard effects such as a 40% decrease in the probability of performing vigorous exercise. For elderly females, no consistent evidence of ex ante moral hazard was found.

3. The model of health insurance with financial incentives for illness prevention

In section 3, I expand the basic model and use the outcomes of the model to study how market power influences optimal health insurance with financial incentives for illness prevention. First, in section 3.1, I add illness prevention to the basic model. In addition, I compare the situations for which an individual prefers being insured with and without rewards for illness prevention. Afterwards, in section 3.2, I study the model with a monopolist. Subsequently, in section 3.3, I study the situation where individuals differ in income and compare the outcomes of a monopolist with the outcomes under perfect competition. Thereafter, I consider a situation where the insurer cannot observe the risk probabilities of individuals which leads to moral hazard. Finally, I show how the observability of effort can be utilized to engage in price discrimination and how this affects social welfare. I find the insurer can only engage in menu pricing if individuals differ in their willingness to pay for insurance with effort rewards.

3.1. Adding effort to the basic model

Starting from the model I set up in section 2.3.3.1, I assume individuals can either exert effort ($e = 1$) or not exert effort ($e = 0$). Exerting effort reduces the probability of being ill $(1 - t)$, but also costs part of the individual's income $(1 - r)$:

$p(e)$ with $p(0) = p$ and $p(1) = tp$ with $0 < t < 1$
$y(e)$ with $y(0) = y$ and $y(1) = ry$ with $0 < r < 1$

In the absence of insurance, an individual’s expected utility is given by:

$$V_{N,pc}(e) = (1 - p(e))U(y(e)) + p(e)U(y(e) - m) \tag{6}$$

The insurance company observes individuals exerting effort and rewards individuals that do so. The insurer has an incentive to do so because the expected costs for individuals that exert effort are lower compared to individuals who do not exert effort.

Individuals that show healthy behaviour have a lower probability of being ill and therefore pay a lower premium:

$$\pi_{pc}(e) = p(e)m \tag{7}$$

The insurance company pays out m when the individual is ill. If an individual selects insurance, the individual's utility will always be:

$$V_{I,pc}(e) = U\left(y(e) - \pi_{pc}(e)\right) \tag{8}$$

In section 3.2, I study the situation with a monopolist. If I perform a Taylor expansion with a monopolist, the outcomes (see Appendix A) provide little intuition. Therefore, to simplify, I assume individuals have an isoelastic utility function: $u(x) = \frac{x^{1-\theta}}{1-\theta}$ with $\theta > 0$. I can rewrite equations 6 and 8 as:

$$V_{N,pc}(e) = (1 - p(e))\left(\frac{y(e)^{1-\theta}}{1-\theta}\right) + p(e)\left(\frac{(y(e) - m)^{1-\theta}}{1-\theta}\right) \tag{9}$$

$$V_{I,pc}(e) = \frac{\left(y(e) - \pi_{pc}(e)\right)^{1-\theta}}{1-\theta} \tag{10}$$

Using the following equation, I can calculate for which premium the individual is indifferent between being insured and not being insured:

$$V_{N,pc}(e) = V_{I,pc}(e) \tag{11}$$

The premium for which the consumer is indifferent equals:

$$\pi_{pc}(e) = y(e) - \left(\left(1 - p(e)\right)y(e)^{1-\theta} + p(e)(y(e) - m)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{12}$$

The right-hand side of equation 12 is increasing in θ. If individuals are more risk-averse, implying a higher θ, the premium for which they are indifferent between being insured and not being insured is larger. In addition, the equation is increasing in m. Higher medical spending leads to less utility when ill, making the insurance more attractive. Also, as the probability of being ill increases, insurance becomes more attractive because the chance that the individual otherwise loses utility through medical spending increases. On the contrary, the equation is decreasing in y. If individuals have a lower income, they expect to lose a larger share of their income when ill and therefore are willing to pay a higher premium.

Since $p(e) > 0$ and $\theta > 0$, the right-hand side of equation 12 is always greater than zero. Thus, the price individuals are willing to pay for insurance is always positive. As shown in equation 5, individuals with an isoelastic utility function prefer being insured under fair insurance. Therefore, individuals are always prepared to pay at least $p(e)m$ for insurance.

Since the insurer makes a profit of zero on a perfectly competitive market, the insurer has no preference in offering insurance with or without rewards for illness prevention. However, in section 3.1.1, I will show individuals prefer insurance with or without rewards for illness prevention based on the values of t and r. I assume the insurer will offer the preferred insurance of individuals because this insurance provides individuals with more utility, while the insurer is indifferent.

3.1.1. Comparison fair insurance with and without effort rewards

Whether an individual prefers the insurance with or without effort rewards, depends on the parameters t and r, keeping all other variables constant. We can calculate the values of t and r for which an individual is indifferent between being insured with and without exerting effort by solving the following equation:

$$V_{I,pc}^{e} = V_{I,pc}^{ne} \tag{13}$$

Using $u(x) = \frac{x^{1-\theta}}{1-\theta}$, I solve:

$$\frac{(y - pm)^{1-\theta}}{1-\theta} = \frac{(ry - tpm)^{1-\theta}}{1-\theta} \tag{14}$$

Keeping all other variables constant, an individual is indifferent between being insured with and without exerting effort if:

$$t = 1 - \frac{y(1-r)}{pm} \tag{15}$$

Or if:

$$r = 1 - \frac{pm(1-t)}{y} \tag{16}$$

Thus, the individual prefers insurance with effort if:

$$t < 1 - \frac{y(1-r)}{pm} \tag{17}$$

Or if:

$$r > 1 - \frac{pm(1-t)}{y} \tag{18}$$

Thus, an individual prefers insurance with effort for low values of t and high values of r. The interpretation behind this is as follows: for low values of t, exerting effort to be healthy reduces the probability of being ill by a lot. This reduces the price of insurance $\pi(e)_{pc}$, making insurance with effort more attractive. At the same time, for high values of r, the costs of exerting effort to the individual are low.

3.2. The basic model with a monopolist

In section 3.1, I assumed that the insurance company finds itself in a perfectly competitive market. Then, the fair insurance premium was $\pi(e)_{pc} = p(e)m$. In this part, I will instead assume the insurer is a monopolist. I use subscript m to denote the monopolist market. The monopolist can include a surcharge s in the premium:

$$\pi(e)_m = p(e)m + s \tag{19}$$

Where $s > 0$. In the absence of insurance, an individual's expected utility is given by:

$$V_{N,m}^{ne} = (1-p)U(y) + pU(y-m) \tag{20}$$

$$V_{N,m}^{e} = (1-tp)U(ry) + tpU(ry-m) \tag{21}$$

If an individual selects insurance, the utility will be:

$$V_{I,m}^{ne} = U(y - pm - s) \tag{22}$$

$$V_{I,m}^{e} = U(ry - tpm - s) \tag{23}$$

Once again, to simplify, I assume individuals have an isoelastic utility function: $u(x) = \frac{x^{1-\theta}}{1-\theta}$. I can rewrite $V_{N,m}^{ne}, V_{N,m}^{e}, V_{I,m}^{ne}$ and $V_{I,m}^{e}$ as:

$$V_{N,m}^{ne} = (1-p)\frac{y^{1-\theta}}{1-\theta} + p\frac{(y-m)^{1-\theta}}{1-\theta} \tag{24}$$

$$V_{N,m}^{e} = (1-tp)\frac{(ry)^{1-\theta}}{1-\theta} + tp\frac{(ry-m)^{1-\theta}}{1-\theta} \tag{25}$$

$$V_{I,m}^{ne} = \frac{(y-pm-s)^{1-\theta}}{1-\theta} \tag{26}$$

$$V_{I,m}^{e} = \frac{(ry - tpm - s)^{1-\theta}}{1-\theta} \tag{27}$$

Using the following equations, I can calculate for which premium the individual is indifferent between being insured and not being insured:

$$V_{N,m}^{ne} = V_{I,m}^{ne} \tag{28}$$

$$V_{N,m}^{e} = V_{I,m}^{e} \tag{29}$$

The premiums for which the consumer is indifferent equal:

$$\pi_m^{ne} = y - \left((1-p)y^{1-\theta} + p(y-m)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{30}$$

$$\pi_m^{e} = ry - \left((1-tp)(ry)^{1-\theta} + tp(ry-m)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{31}$$

The insurer will set the price of insurance at the point where an individual is indifferent between being insured and not being insured. In addition, the insurer can decide whether to offer a contract with or without effort and selects the contract which returns the highest profit. This choice depends on the value of t and r. The profit function for the insurer can be written as:

$$P_m(c,e) = \pi_m(e) \cdot c - p(e)m \cdot c \tag{32}$$

Where c is the number of contracts sold. Since all individuals are equal, c will be the same if the insurer chooses either the contract with or without effort. The insurer offers the contract with effort if:

$$P_m^{e} > P_m^{ne} \tag{33}$$

And, in terms of premiums if:

$$\pi_m^{e} > \pi_m^{ne} - pm(1-t) \tag{34}$$

If this is the case, the insurer will increase π_m^{ne} until all individuals will prefer π_m^{e}. This way the insurer maximizes profits.

3.3. Income differences

Next, suppose individuals differ in their income level. Incomes y_i are distributed across the population on the interval $\left[\underline{y}, \overline{y}\right]$ according to the continuous uniform cumulative distribution function $G(y)$. Once again, the total population is normalized to one.

As before, I assume $u(x) = \frac{x^{1-\theta}}{1-\theta}$. In this subsection, I also assume $\theta = 2$. In that case, the utility function is $u(x) = -\frac{1}{x}$. Without insurance, the individual's expected utility equals:

$$V_N^{ne} = (1-p)\left(-\frac{1}{y_i}\right) + p\left(-\frac{1}{y_i - m}\right) \tag{35}$$

With insurance, the individual's expected utility equals:

$$V_I^{ne} = -\frac{1}{y_i - \pi^{ne}} \tag{36}$$

An individual prefers to be insured if:

$$V_I^{ne} \geq V_N^{ne} \tag{37}$$

The willingness to pay is the premium for which an individual is indifferent between being insured and uninsured:

$$\pi^{ne} = \frac{pmy_i}{y_i - m + pm} \tag{38}$$

For this to hold, we must have $y_i(y_i - m) \neq 0$ and $p \neq -\frac{y_i - m}{m}$. Since $y_i > m$, $y_i(y_i - m) > 0$ and $-\frac{y_i - m}{m} < 0$ these restrictions hold. Note the premium for which the individual is indifferent is decreasing in income, since:

$$\frac{d\pi^{ne}}{dy_i} = \frac{-pm^2(1-p)}{(y_i - m + pm)^2} < 0 \tag{39}$$

Individuals with a low income expect to lose a larger share of their income when ill. Therefore, their willingness to pay is higher than individuals with a high income.

By rewriting equation 38, all individuals with income y_i lower than $\frac{\pi^{ne} m(1-p)}{\pi^{ne} - pm}$ will purchase insurance. In that case, we must have $\pi^{ne} \neq pm$ which is the case under fair insurance. This can be explained by the fact that equation 38 shows the premium for which an individual is indifferent between being insured and uninsured. However, under fair insurance, there are no indifferent individuals: all individuals prefer being insured. First, I will describe the situation with fair insurance and then describe the situation under monopoly.

3.3.1. Perfect competition

Under perfect competition, the premium equals:

$$\pi_{pc}^{ne} = pm \tag{40}$$

As shown before, all individuals will purchase insurance in this case. To illustrate, the insurer's profit equals:

$$P_{pc} = \left(\pi_{pc}^{ne} - pm\right) \cdot 1 = 0 \tag{41}$$

3.3.2. Monopoly

If the insurer is a monopolist, the premium equals:

$$\pi_{m}^{ne} = pm + s \tag{42}$$

Now, the maximum income to prefer insurance equals:

$$\frac{\pi_{m}^{ne} m(1-p)}{\pi_{m}^{ne} - pm} \tag{43}$$

The number of individuals who purchase insurance for a given premium π_{m}^{ne} is:

$$\int_{\underline{y}}^{\frac{\pi_{m}^{ne} m(1-p)}{\pi_{m}^{ne} - pm}} g(y_i)\, dG = \frac{\frac{\pi_{m}^{ne} m(1-p)}{\pi_{m}^{ne} - pm} - \underline{y}}{\overline{y} - \underline{y}} \tag{44}$$

The monopolist profit can be represented by the following function:

$$P_m = (\pi_{m}^{ne} - pm)\left(\frac{\frac{\pi_{m}^{ne} m(1-p)}{\pi_{m}^{ne} - pm} - \underline{y}}{\overline{y} - \underline{y}}\right) \tag{45}$$

The insurer maximizes profits with respect to the premium:

$$\frac{\partial P_m}{\partial \pi_{m}^{ne}} = \frac{m(1-p) - \underline{y}}{\overline{y} - \underline{y}} < 0 \tag{46}$$

Equation 46 shows profits are decreasing in the premium. Still, the insurer can make positive profits. The insurer sets the premium as high as possible while making sure each individual still prefers being insured above not being insured. This is at the point where the highest-earning individuals are indifferent between being insured and being uninsured.

Thus, the monopolist selects the following premium:

$$\pi_m^{ne} = \frac{pm\overline{y}}{\overline{y} - m + pm} \tag{47}$$

This premium is greater than the actuarially fair premium since $\frac{pm\overline{y}}{\overline{y}-m+pm} = (pm)\frac{\overline{y}}{\overline{y}-m+pm}$ and $\overline{y} > \overline{y} - m + pm$ since $-m + pm < 0$. This leads to positive profits for the insurer since the costs per individual remain pm. With the premium of equation 47, all individuals prefer being insured. All individuals with an income lower than the highest-earning individuals have a higher willingness to pay for insurance compared to the highest-earning individuals. This is because they expect to lose a larger part of their income when ill. From the monopolist's perspective, insuring all individuals maximizes profits. The marginal revenue, which is the premium in equation 47, remains larger than the marginal cost, pm, for each individual. Entering the premium into the profit function, the insurer makes the following profit:

$$P_m = \frac{pm^2(1-p)}{\left(\overline{y} - m(1-p)\right)\left(\overline{y} - \underline{y}\right)} \tag{48}$$

3.3.3. Adding effort

If we add effort to the model with differentiation in income, there are eight possible situations, depending on the preferences of individuals, the preferences of insurers and the type of market. Table 1 describes all potential situations and outcomes. Situations 2, 3, 6 and 7 might come across as counterintuitive. For example, in situation 3, individuals do not prefer exerting effort when uninsured but do prefer exerting effort when insured. Why would an individual not prefer exerting effort anymore after being insured while being rewarded for it? However, there are values of t and r for which effort pays off only while either insured or uninsured. In Appendix B, I prove situations 2, 3, 6 and 7 are possible for certain values of t and r. In section 3.3.6, I will discuss how the social optimum is affected by the possibility of the different situations. I did not find the profit of the insurer in situations 6 and 7 because rewriting the indifference premium in terms of y_i and then entering this value into the profit function was mathematically complex. Situations 1 and 5 were described above. To study the role of effort, I will describe situations 4 and 8 next.

Suppose the individual prefers exerting effort to not exerting effort when uninsured:

$$V_N^e \geq V_N^{ne} \tag{49}$$

The individual prefers to be insured with exerting effort to not being insured with exerting if:

$$V_I^e \geq V_N^e \tag{50}$$

Then, an individual will have a willingness-to-pay for insurance of:

$$\frac{trpmy_i}{ry_i - m + tpm} \tag{51}$$

Thus, all individuals with income higher than $\frac{\pi^e m(1-tp)}{r(\pi^e - tpm)}$ will purchase insurance.

3.3.4. *Perfect competition*

Under perfect competition, the premium equals:

$$\pi_{pc}^e = tpm \tag{52}$$

As shown before, all individuals will purchase insurance in this case. The insurer's profit equals zero.

3.3.5. *Monopoly*

*S*uppose the insurer prefers offering a contract with effort:

$$P_m^e \geq P_m^{ne} \tag{53}$$

If the insurer is a monopolist, the premium equals:

$$\pi_m^e = tpm + s \tag{54}$$

Now, the maximum income to prefer insurance equals:

$$\frac{\pi^e m(1 - tp)}{r(\pi^e - tpm)} \tag{55}$$

The number of individuals who purchase insurance for a given premium π_m^{ne} is:

$$\int_{\underline{y}}^{\frac{\pi^e m(1-tp)}{r(\pi^e - tpm)}} g(y_i)\, dG = \frac{\frac{\pi^e m(1 - tp)}{r(\pi^e - tpm)} - \underline{y}}{\overline{y} - \underline{y}} \tag{56}$$

The monopolist profit can be represented by the following function.

$$P_m = (\pi_m^e - tpm)\left(\frac{\frac{\pi^e m(1 - tp)}{r(\pi_m^e - tpm)} - \underline{y}}{\overline{y} - \underline{y}}\right) \tag{57}$$

The insurer maximizes profits with respect to the premium:

$$\frac{\partial P_m}{\partial \pi_m^{ne}} = \frac{\frac{m(1-tp)}{r} - \underline{y}}{\overline{y} - \underline{y}} < 0 \tag{58}$$

Once again, the profits are decreasing in the premium. The insurer can charge a small surcharge while still insuring every individual to make positive profits. Thus, the insurer sets the premium as high as possible while making sure each individual still prefers being insured above not being insured. The monopolist selects the following premium:

$$\frac{trpm\overline{y}}{r\overline{y} - m + tpm} \tag{59}$$

With this premium, all individuals prefer being insured. Entering the premium into the profit function, the insurer makes the following profit:

$$P_m = \frac{tm^2(1-tp)}{\left(r\overline{y} - m(1-tp)\right)\left(\overline{y} - \underline{y}\right)} \tag{60}$$

Once again, whether the insurer prefers offering insurance with or without effort rewards depends on the parameters t and r, keeping all other variables constant.

3.3.6. Comparison perfect competition and monopoly

In this subsection, I will explain how a change in the market power of the insurer affects the social optimum. As explained before, in a market of perfect competition, the insurer is indifferent between insurance with or without a reward for illness prevention and will offer the preferred insurance of individuals. Here, individuals are insured while paying the actuarially fair premium. This provides individuals with more utility compared to being uninsured. In addition, individuals can purchase insurance with or without effort rewards based on their preference. Therefore, individuals exert the optimal amount of effort. The preferred insurance also provides individuals with more utility compared to the other contract. Next to that, the insurer can provide all individuals with insurance and makes a profit of zero.

Table 1

The eight possible situations of the model with income differences depending on the preferences of individuals and insurers and the type of market

	Individual preference - uninsured	Individual preference - insured	Insurer preference	Indifference premium	Profit insurer
Perfect competition					
Situation 1	$V_N^{ne} \geq V_N^e$	$V_I^{ne} \geq V_I^e$	Indifferent	$\frac{pmy_i}{y_i - m + pm}$	0
Situation 2	$V_N^{ne} \geq V_N^e$	$V_I^{ne} \leq V_I^e$	Indifferent	$\frac{-y_i{}^2 + my_i + ry_i{}^2 - rmy_i + rpmy_i}{y_i - m + pm}$	0
Situation 3	$V_N^{ne} \leq V_N^e$	$V_I^{ne} \geq V_I^e$	Indifferent	$\frac{-r^2y_i{}^2 + rmy_i + ry_i{}^2 - my_i + tpmy_i}{ry_i - m + tpm}$	0
Situation 4	$V_N^{ne} \leq V_N^e$	$V_I^{ne} \leq V_I^e$	Indifferent	$\frac{trpmy_i}{ry_i - m + tpm}$	0
Monopoly					
Situation 5	$V_N^{ne} \geq V_N^e$		$P_m^{ne} \geq P_m^e$	$\frac{pmy_i}{y_i - m + pm}$	$\frac{pm^2(1-p)}{\left(\overline{y} - m(1-p)\right)\left(\overline{y} - \underline{y}\right)}$
Situation 6	$V_N^{ne} \geq V_N^e$		$P_m^{ne} \leq P_m^e$	$\frac{-y_i{}^2 + my_i + ry_i{}^2 - rmy_i + rpmy_i}{y_i - m + pm}$	
Situation 7	$V_N^{ne} \leq V_N^e$		$P_m^{ne} \geq P_m^e$	$\frac{-r^2y_i{}^2 + rmy_i + ry_i{}^2 - my_i + tpmy_i}{ry_i - m + tpm}$	
Situation 8	$V_N^{ne} \leq V_N^e$		$P_m^{ne} \leq P_m^e$	$\frac{trpmy_i}{ry_i - m + tpm}$	$\frac{tm^2(1-tp)}{\left(r\overline{y} - m(1-tp)\right)\left(\overline{y} - \underline{y}\right)}$

Note. Profit insurer of situations 6 and 7 not found due to mathematical complexity.

In contrast to a market of perfect competition, the monopolist can decide which insurance to offer and will have a preference based on the parameters t and r. Since the monopolist can make positive profits, the insurer will have a strict preference for which insurance to offer. If the insurer prefers to offer insurance which is also preferred by individuals, the only difference compared to a market of perfect competition is that individuals pay a surcharge. The insurer receives that surcharge which leads to positive profits. This leads to a shift in the surplus from the individuals to the insurer. In this situation, individuals remain insured and exert the optimal amount of effort. However, for certain values of t and r, the preferences of the insurer and individuals do not align. This leads to a welfare loss compared to a market of perfect competition. Individuals receive less utility because they are not offered their optimal insurance. In addition, individuals do not exert the optimal amount of effort. To provide more intuition, I will discuss a numerical example.

I select values for the following variables: $\theta = 2, t = 0.7, p = 0.3, m = 50$ and $y_i = [60, 100]$. Suppose individuals prefer insurance with effort rewards above insurance without effort rewards. Using equation 16, individuals with the lowest income prefer insurance with effort rewards above insurance without effort rewards if $r > 0.925$. The individuals with the highest income prefer insurance with effort rewards above insurance without effort rewards if $r > 0.955$. Next, suppose the insurer is a monopolist and has the preferences of situation 7 (see Table 1). In this situation, the insurer prefers offering insurance without effort rewards, given that the individuals prefer exerting effort when uninsured. Using equations 124 and 125 (see Appendix B) I find the insurer has the preferences of situation 7 if $r > 0.995$. Thus, if $r > 0.995$ the insurer will offer insurance without rewards to individuals who would rather prefer insurance with rewards. This example shows there can be situations where the preferences of the insurer and individuals are not aligned due to the market power of the insurer. Since the minimum value for r in the example above is increasing in income, there is also a situation where only a part of the individuals does not have their preferences aligned with the insurer. In the example, this would have been the case if the minimum value for r of the insurer was somewhere in between the minimum value for r of the highest and lowest incomes. Therefore, we can conclude the preferences of the insurer may not be in line with the whole population but could still be in line with a part of the population.

Next, I will summarize the two main results of sections 3.1, 3.2 and 3.3. First, I find that all individuals remain insured when the insurer is a monopolist when individuals only differ in income. In the model, the marginal revenues are larger than the marginal costs for each individual. The monopolist sets the premium equal to the indifference premium of the highest-earning individuals. Since these individuals have the lowest willingness to pay, all individuals prefer purchasing insurance at this price. Second, I show there can be situations where the preferences of the insurer and (a share of) individuals are not aligned due to the market power of the insurer. This can lead to a social welfare loss since individuals are not offered the type of insurance which maximizes their utility. In addition, individuals do not exert the optimal amount of effort. Thus, I show the socially optimal outcome under perfect competition is not always possible under monopoly.

3.4. High and low-risk individuals

From now onwards, I once again assume individuals have the same income y. Next to that, suppose individuals can differ in the probability of being ill (Zweifel et al., 2009). A fraction of the population $1-q$ has a high probability of being ill p_H. The rest of the population q has a low probability of being ill p_L, where $p_L < p_H$. I use subscript L and H to distinguish between risk types. I assume $q > 0$ so there is at least one individual of each risk type in the population.

I first assume the insurer can observe p_i. The expected utility of risk type i for being either uninsured or insured equals:

$$V_{N,m,i} = (1-p_i)U(y) + p_i U(y-m) \tag{61}$$

$$V_{I,m,i} = U\left(y - \pi_{m,i}\right) \tag{62}$$

If the insurer can identify the risk type of individuals, the premium for risk type i equals:

$$\pi_{m,i} = p_i m + s_i \tag{63}$$

Individuals will purchase insurance in this situation, as long as the surcharge is not too large. The only difference is that the insurer offers two types of insurance with differing premiums for the two risk types. All individuals remain insured, and we have an efficient outcome.

Next, I assume only individuals themselves know their risk type. The insurer does not know the risk type of individuals but does know the share of low-risk individuals q. The insurer can either offer one contract to the whole population or offer two contracts, one for each risk type. In reality, this might depend on whether the insurer is constrained by the law to not be allowed to differentiate between individuals.

First, if the insurer offers one contract, the insurer will base the premium on the average probability of being ill in the population $\overline{p}$, which is defined as:

$$\overline{p} = q p_L + (1-q) p_H \tag{64}$$

Where $p_L < \overline{p} < p_H$. The premium for insurance will then be:

$$\pi_m^{ne} = \overline{p}m + s \tag{65}$$

I assume $u(x) = \frac{x^{1-\theta}}{1-\theta}$ and $\theta = 2$. For low-risk types, the expected utilities are:

$$V_{N,m,L} = (1 - p_L)\left(-\frac{1}{y}\right) + p_L\left(-\frac{1}{y - m}\right) \tag{66}$$

$$V_{I,m,L} = -\frac{1}{y - \overline{p}m - s} \tag{67}$$

Low-risk individuals purchase the insurance if:

$$\pi_m^{ne} \leq \frac{p_L my}{y - m + p_L m} \tag{68}$$

Whether low-risk individuals purchase insurance depends on the difference between their risk of being ill and the average risk of being ill. The distribution of risk across the population plays an important role here. If there are many low-risk individuals in the population $\overline{p}$ will be very close to p_L and the loss resulting from risk being unobservable will be small for low-risk individuals. Compared to the individuals in the basic monopolist model, the low-risk individuals are worse off because $\overline{p} > p_L$, leading to a higher premium for them in all cases. For high-risk individuals, this type of insurance will generate more value compared to when their risk type is observable since $p_H > \overline{p}$. The high-risk individuals benefit from the fact that the insurer does not know their risk type.

The insurer attracts both risk types if the premium is smaller or equal to the right-hand side of equation 68. The monopolist sets the premium equal to the indifference price of low-risk individuals. Then, the insurer makes the following profit:

$$P_m = \frac{p_L my}{y - m + p_L m} - \overline{p}m \tag{69}$$

In this case, high-risk individuals pay a smaller premium compared to the efficient situation while low-risk individuals pay the same premium. The profits of the insurer decrease, as the whole surplus of high-risk individuals cannot be extracted anymore. If the insurer sets the premium above the indifference price of low-risk individuals, the insurer only attracts high-risk individuals. Then, the insurer maximizes profits by setting the premium equal to the indifference price of high-risk individuals:

$$P_m = \left(\frac{p_H my}{y - m + p_H m} - p_H m\right)(1 - q) \tag{70}$$

Thus, using equations 69 and 70, the insurer will insure all individuals if:

$$q \geq 1 - \frac{\big(p_L y - \overline{p}(p_L m - m + y)\big)(p_H m - m + y)}{p_H m(p_L m - m + y)(1 - p_H)} \tag{71}$$

This shows the preference of the insurer depends on the distribution of risk types in the population. If equation 71 does not hold, only high-risk individuals are insured. Low-risk individuals do not prefer the insurance targeted at the high-risk individuals and therefore remain uninsured. The high-risk individuals pay the same premium as in an efficient situation. The insurer has lower profits compared to the efficient situation, as only a part of the population is insured. Thus, when the risk type is unobservable to the insurer, this leads to a social welfare loss.

Second, the insurer can offer two contracts that are designed for each risk type. The idea is that individuals will select themselves into the insurance which is targeted at them. Suppose the insurer offers a contract with premium $\pi_{m,L} = p_L m + s$ and another contract with premium $\pi_{m,H} = p_H m + s$. Since medical expenditures are constant when ill, we have:

$$\pi_{m,L} < \pi_{m,H} \tag{72}$$

Low-risk individuals will purchase the insurance targeted at them as long as s is not too large. For high-risk individuals, the insurance targeted at them also provides them with more utility compared to not being insured if s is not too large. However, these individuals will purchase the insurance targeted at low-risk individuals. They will do so because they pay a lower premium but will still be insured against the same medical costs, while the insurer does not know they are high-risk individuals. In that case, every individual will want to purchase the insurance targeted at the low-risk type. Yet, for the insurer, this is not profitable if $p_L m + s < \overline{p}m$. Then, the insurer will not offer the low-risk insurance. In this model, the insurer will only offer the high-risk insurance. Only the high-risk individuals will purchase this, assuming the contract is priced at the indifference premium of high-risk individuals. Since this is the premium for which high-risk individuals are indifferent and low-risk individuals have a lower willingness to pay for insurance, low-risk individuals will prefer being uninsured. Once again, the unobservability of risk type leads to a loss in social welfare.

3.5. Effort discount

When illness prevention is observable to the insurer, the social welfare loss found in section 3.4 can potentially be mitigated. In this subsection, I will first explain how the observability of illness prevention can be utilized by the insurer to distinguish between risk types via menu pricing. Next, I will show why this is not possible for the insurer in this model. Afterwards, I will make an additional assumption in the model which facilitates menu pricing and explain why this can be attractive to the insurer.

First, the insurer knows high-risk individuals are willing to pay more for insurance compared to low-risk insurance because high-risk individuals expect a larger loss when ill. However, the willingness to pay of individuals is private information. With menu pricing, the insurer attempts to reveal this information by selling two types of contracts. The insurer can offer a contract with effort rewards and a contract without effort rewards. The idea is that each contract will attract a certain type of consumer more than the other contract. For this to be possible, the costs and benefits of selecting insurance with effort rewards must differ between individuals. In terms of utility, the gain in utility of switching from insurance without effort rewards to insurance with effort rewards must be greater for one type of individual than the other. Then, individuals will select themselves into the contract which they prefer. However, in this model individuals will always have the same preference for the type of insurance. This is because individuals only differ in their probability of being ill. Therefore, exerting effort leads to the same reduction in income for both types of individuals. The benefits of exerting effort are also equal because the insurer cannot distinguish between risk types. Then, the change in utility in moving from insurance without effort rewards to insurance with effort rewards is the same for both risk types. This is because individuals will pay the same premium for each type of insurance since the insurer does not take their probability of being ill into account.

To prove the effort preferences of individuals when insured do not depend on their probability of being ill, I will compare situations 7 and 8 in Table 1. Here, the effort preferences when uninsured are equal. Then, if I compare the indifference premiums of situations 7 and 8, I find the following:

$$\frac{-r^2{y_i}^2 + rmy_i + r{y_i}^2 - my_i + tpmy_i}{ry_i - m + tpm} - \frac{trpmy_i}{ry_i - m + tpm} =$$
$$\frac{(ry_i - m + tpm)(y_i - ry_i)}{(ry_i - m + tpm)} = y_i(1-r) \tag{73}$$

Equation 73 shows that the probability of being ill does not play a role in the preference of being insured with or without effort rewards. Only income and the costs of exerting effort play a role, but these factors are equal for all individuals. Thus, if the insurer offers two contracts, all individuals will prefer the same contract and menu pricing will not work.

Next, I will make an additional assumption in the model which facilitates menu pricing and explain why this can be attractive to the insurer. Suppose the costs of exerting effort differ per risk type. For example, if high-risk individuals eat an apple a day, they already receive a reduction in the probability of being ill $1-t$. Low-risk individuals are already relatively healthy and therefore will need to go for a run each day to reduce their probability of being ill with $1-t$. Then, we have:

$$r_H > r_L \tag{74}$$

Now, individuals will differ in their preferences for effort when insured because the costs of exerting effort are different. We can also see this in equation 73, where the preferences depend on r. I assume the insurer is a monopolist. Next to that, I assume all individuals prefer exerting effort when uninsured and insured under perfect competition:

$$V_{N,i}^{e} \geq V_{N,i}^{ne} \; and \; V_{N,i,pc}^{e} \geq V_{N,i,pc}^{ne} \tag{75}$$

High-risk individuals have a greater willingness to pay to move from a contract without effort rewards to a contract with effort rewards compared to high-risk individuals:

$$V_{I,H}^{e} - V_{I,H}^{ne} > V_{I,L}^{e} - V_{I,L}^{ne} \tag{76}$$

This follows from the assumption that high-risk individuals have lower costs when exerting effort compared to low-risk individuals. The insurer can use this higher willingness to pay to offer a contract with rewards to high-risk individuals and a contract without rewards to low-risk individuals. For individuals to select the contract targeted at them, we have the following constraints for low-risk individuals:

$$V_{I,L}^{ne} - \pi_m^{ne} \geq V_{N,L}^{e} \tag{77}$$

$$V_{I,L}^{ne} - \pi_m^{ne} \geq V_{I,L}^{e} - \pi_m^{e} \tag{78}$$

We have the following constraints for high-risk individuals:

$$V_{I,H}^{e} - \pi_m^{e} \geq V_{N,H}^{e} \tag{79}$$

$$V_{I,H}^{e} - \pi_m^{e} \geq V_{I,H}^{ne} - \pi_m^{ne} \tag{80}$$

To maximize profits, the insurer sets the premium of insurance without effort rewards equal to the indifference premium of low-risk individuals:

$$\pi_m^{ne} = V_{I,L}^{ne} - V_{N,L}^{e} \tag{81}$$

Then, high-risk individuals prefer purchasing insurance with effort rewards if:

$$\pi_m^{e} \leq V_{I,H}^{e} - (V_{I,H}^{ne} - \pi_m^{ne}) \tag{82}$$

Combining equations 81 and 82, the insurer maximizes profits by setting the following price for the contract with effort rewards:

$$\pi_m^e = V_{I,H}^e - V_{I,H}^{ne} + V_{\mathrm{I},L}^{ne} - V_{N,L}^e \tag{83}$$

High-risk individuals will only purchase this insurance if the premium in equation 83 is smaller or equal to their indifference premium. In Appendix C, I show that whether the premium in equation 83 is smaller than the indifference premium depends on the costs of exerting effort. Then, high-risk individuals purchase insurance with effort rewards and obtain either a positive surplus or a surplus of zero. Low-risk individuals purchase insurance without effort rewards and get a surplus of zero. If the insurer sells to both risk types, the profits are the following:

$$P_m = \left(V_{I,L}^{ne} - V_{N,L}^e - p_L m\right)q + \left(V_{I,H}^e - V_{I,H}^{ne} + V_{\mathrm{I},L}^{ne} - V_{N,L}^e - tp_H m\right)(1-q)$$

Next, the insurer decides whether to engage in menu pricing or offer one price. If the insurer offers one price, there are two options. First, the insurer can sell the contract with effort rewards to all individuals at the indifference premium of low-risk individuals. Then, the profits are the following:

$$P_m = V_{I,L}^e - V_{N,L}^e - qtp_L m - (1-q)tp_H m \tag{84}$$

Second, the insurer can sell the contract with effort rewards to high-risk individuals at the indifference premium of high-risk individuals. Then, the profits are as follows:

$$P_m = \left(V_{I,H}^e - V_{N,H}^e - tp_H m\right)(1-q) \tag{85}$$

Thus, the insurer restricts sales to high-risk individuals if:

$$\mathrm{q} < \frac{V_{N,H}^e - V_{I,H}^e + V_{I,L}^e - V_{N,L}^e}{V_{N,H}^e - V_{I,H}^e + tp_L m} \equiv q_0 \in (0,1) \tag{86}$$

Then, the profits from selling only the contract with effort rewards are as follows:

$$P_m^e = \begin{cases} \left(V_{I,H}^e - V_{N,H}^e - tp_H m\right)(1-q) \text{ } if \text{ } q \le q_0 \\ V_{I,L}^e - V_{N,L}^e - qtp_L m - (1-q)(qtp_H m) \text{ } if \text{ } q > q_0 \end{cases} \tag{87}$$

Next, I will investigate for which values of q menu pricing is optimal to the monopolist. Suppose $q \le q_0$, that is, the monopolist restricts sales to high-risk individuals with one price.

Then, menu pricing increases profits if the proportion of low-risk individuals is not too small such that:

$$q > \frac{V_{N,L}^{e} - V_{I,L}^{ne} + V_{I,H}^{ne} - V_{N,H}^{e}}{V_{I,H}^{ne} - V_{N,H}^{e} - p_L m} \equiv \underline{q} \in (0,1) \tag{88}$$

For the trade-off between menu pricing and only selling to high-risk individuals, there are two opposing effects. First, under menu pricing, low-risk individuals purchase insurance which yields a margin of $\left(V_{I,L}^{ne} - V_{N,L}^{e} - p_L m\right)$. Second, under menu pricing, high-risk individuals potentially pay a lower premium of $V_{I,H}^{e} - V_{I,H}^{ne} + V_{\mathrm{I},L}^{ne} - V_{N,L}^{e}$ instead of $V_{I,H}^{e} - V_{N,H}^{e}$, which is the premium when the insurer only sells to high-risk individuals. As long as the share of high-risk individuals is not too large, the first effect dominates, and menu pricing increases the profits of the insurer.

Next, suppose $q > q_0$, that is, the monopolist sells the contract with effort rewards to all individuals at one price. Then, menu pricing increases profits if:

$$q < \frac{V_{I,L}^{e} - V_{I,L}^{ne} + V_{I,H}^{ne} - V_{I,H}^{e}}{V_{I,H}^{ne} - V_{I,H}^{e} + tp_L m - p_L m} \equiv \overline{q} \in (0,1) \tag{89}$$

First, for low-risk individuals, the reduction of the margin when moving from offering one insurance to all individuals to menu pricing is given by $V_{I,L}^{e} - V_{I,L}^{ne} - tp_L m + p_L m > 0$. Second, for high-risk individuals, the increase of the margin is given by $V_{I,L}^{e} - V_{\mathrm{I},L}^{ne} + V_{I,H}^{ne} - V_{I,H}^{e} < 0$. The net effect is positive if the share of high-risk individuals is large enough.

Thus, menu pricing is optimal if the proportion of high-risk individuals is neither too small nor too large:

$$\overline{q} > q_0 > \underline{q} \tag{90}$$

If $\overline{q} > q > q_0$, the insurer prefers menu pricing above selling insurance with rewards to all individuals because it increases profits. However, low-risk individuals are sold insurance without effort rewards while they prefer insurance with effort rewards under perfect competition, which is inefficient. In addition, low-risk individuals do not exert effort while they prefer doing so, which is not socially optimal. Also, high-risk individuals pay a higher premium compared to when the insurer offers insurance with rewards to all individuals. Therefore, in this case, menu pricing leads to lower social welfare compared to selling insurance with rewards to all individuals. In contrast, if $\underline{q} < q < q_0$, menu pricing increases welfare. The insurer makes more profits compared to selling only to high-risk individuals. In addition, low-risk individuals can purchase insurance under menu pricing. Next to that, high-risk individuals pay a premium that is lower or equal to their indifference premium. However, low-risk individuals do not exert effort when insured while they prefer doing so under perfect competition.

Finally, I will summarize the main results of sections 3.4 and 3.5. First, in section 3.4, I study the model when individuals differ in their probability of being ill. I show that when the probability of being ill is observable to the insurer, this leads to an efficient outcome. However, when the probability of being ill is unobservable, the insurer faces a problem. If the insurer offers the same contracts as before, high-risk individuals will have an incentive to purchase the insurance targeted at the low-risk individuals. This leads to a large decrease in profits for the insurer. Instead, the insurer can either offer one contract to the whole population or offer a contract which only attracts high-risk individuals. I show that if there is a large share of low-risk individuals, insuring the whole population is more attractive. In addition, I show that the unobservability of risk type always leads to a decrease in social welfare.

Second, in section 3.5, I allowed for the observability of illness prevention. First, I explain how the observability of illness prevention can be utilized by the insurer to distinguish between risk types via menu pricing. Next, I prove this is not possible for the insurer in this model. Afterwards, I assume individuals differ in the costs of exerting effort depending on their risk type. In that case, I show that with menu pricing the social welfare loss found in section 3.4 can potentially be mitigated. In addition, I show that menu pricing always leads to a socially inefficient amount of effort being exerted if all individuals prefer exerting effort. Thus, the observability of illness prevention can lead to a more efficient outcome, if individuals differ in their willingness to pay for insurance with effort rewards, but cannot remove the inefficiencies of the unobservability of risk type completely.

4. Discussion

In this section, I will discuss the most important assumptions of the model and suggest a few improvements for future research. The model contains multiple assumptions which lead to a simplification of a health insurance market. I will discuss the assumptions regarding illness severity levels, the utility function, medical expenditures, the knowledge of the individuals, the ability to exert effort and the difference in effort costs between risk types.

First, I considered only two potential health statuses in the analysis. An individual is either ill or healthy. This assumption implies that being ill leads to a large income loss for the individual due to medical spending. For future research, a more realistic approach would be to have a distribution function with a spectrum of illness severity levels as found in Cuff, Hurley, Mestelman, Muller and Nuscheler (2012) and Kamphorst and Karamychev (2021). This would also require different levels of medical spending for each level of illness severity. In addition, for low expected illness severity levels, illness prevention might have a different effect compared to high expected illness severity levels. Because of this assumption, in section 3.3, the marginal cost was the same for each individual. Since all individuals were willing to pay more for insurance than the marginal costs, insuring all individuals maximizes profits. When allowing for different severity levels, the marginal costs will differ per individual. Then, it might not be profitable to still offer insurance that attracts all individuals.

Second, I assumed individuals have an isoelastic utility function. This type of utility function possesses the standard property that utility is increasing in consumption but at a declining rate. Thus, individuals are assumed to be risk-averse which is fundamental to the outcomes of the model. If individuals were risk-neutral or even risk-seeking, the value of insurance with a fair premium as shown in equation 5 may become negative. The assumption that individuals are risk-averse is often made in models of previous literature (Arrow, 1963; Barigozzi, 2004; Blomqvist, 1997; Cutler & Zeckhauser, 2000; De Meza, 1983; Eggleston, 2000; Ellis & Manning, 2007; Morrisey, 2008; Zweifel & Manning; 2000). A consequence of this assumption was that in the model with income differences, the richest individuals were the first to prefer being uninsured for an increase in the premium. In reality, this is not always the case. For example, Barnett and Vornovitsky (2016) find a positive relationship between household income and both public and private health insurance coverage for American households in 2015. In addition, Morrisey (2008) finds that in the United States wealthier individuals purchase more health insurance. The model in this paper does not include the role of employers and employer-sponsored health insurance. Next to that, low-income individuals may not be able to afford insurance in the United States where the health care market is largely privatised. As discussed before, the assumption that individuals are risk-averse does not necessarily need to hold for individuals to purchase health insurance according to Nyman (1999). Health insurance has the additional value of giving individuals access to expensive medical interventions which would have been affordable in the absence of health insurance. However, this access motive is not present in the model as I assumed medical expenditures are affordable even if the individual is uninsured. If medical expenditures were significantly larger in the case of illness, individuals would be more inclined to purchase insurance. This would also influence illness prevention, making prevention more attractive in the absence of insurance and in the case where the insurer observes prevention.

Third, in sections 3.4 and 3.5, I assumed individuals know their risk type. In reality, individuals likely do not have perfect information about this. For example, some individuals might think they are at a low risk of becoming ill, while in reality, they are high-risk individuals. In health care markets, the physician often plays an important role here. Physicians have the potential to inform both the individuals and the insurer, depending on the structure of the market. Next to that, physicians could influence the effort level of individuals by giving them an accurate estimate of their risks of becoming ill. For future research, a more extensive model could include the role of a physician.

Finally, in section 3.5, I showed that individuals must differ in their willingness to pay for menu pricing to work. To illustrate this, I made an additional assumption that high-risk individuals give up a smaller part of their income to exert effort in comparison to low-risk individuals. The outcomes of this part of the model are a direct consequence of that assumption. There are many other ways individuals might differ in their preferences for effort. For example, in the model, being ill only leads to a financial loss. In reality, individuals will likely not only want to avoid illness because of the financial loss but also the uneasiness and stress associated with being ill. Then, high-risk individuals will have a larger incentive to exert effort compared to low-risk individuals. Thus, incorporating health status next to consumption in the utility function could be a more realistic approach.

5. Conclusion

The introduction of health insurance with financial incentives for illness prevention in the Dutch health insurance market sparked an interesting discussion. Such insurance might lead to a higher degree of adverse selection. As I argued in the introduction, the market power of the insurer could play an important role in whether such insurance is optimal for the whole society. To study this role, I analyzed a theoretical model of health insurance with illness prevention. I will summarize the main results of those situations next.

First, in the basic insurance model with effort, I showed all individuals prefer fair insurance above being uninsured. Insurance removes the uncertainty in the income of individuals when uninsured. With an isoelastic utility function, individuals always have a positive value for health insurance. The value is increasing in the degree of risk-aversion. When risk-aversion increases, the certainty of income under insurance becomes more preferable. In a monopolist market, individuals still prefer being insured if the premium is smaller or equal to their value of insurance. The insurer has the power to select whether to offer insurance with or without financial incentives for illness prevention. An important factor is the effect of illness prevention on the probability of illness. If the effect is larger, the probability of illness is lower which leads to lower expected medical expenditures for the insurer.

Second, in the situation where individuals differ in income, an interesting outcome is that the individuals with the highest income are the first to prefer being uninsured when the monopolist increases the premium. Since medical expenditures are fixed in the model, high-income individuals expect to lose a smaller share of their income compared to low-income individuals. Since individuals are assumed to have decreasing marginal utility, the income loss of medical expenditures leads to a larger utility loss for low-income individuals. Still, for a premium equal to the willingness to pay of individuals with the highest income, the insurer can maximize profits while insuring the whole population. I show there are situations where the preferences of the insurer and (a share of) individuals are not aligned due to the market power of the insurer. This can lead to a social welfare loss since individuals are not offered the type of insurance which maximizes their utility. In addition, individuals do not exert the optimal amount of effort. Thus, I show the socially optimal outcome under perfect competition is not always possible under monopoly.

Finally, I studied the situation where individuals differ in their probability of being ill. I show that when the probability of being ill is observable to the insurer, this leads to an efficient outcome. However, when the probability of being ill is unobservable, this leads to a decrease in social welfare. I show that when illness prevention is observable, the decrease in social welfare can be mitigated with menu pricing. However, menu pricing only works if individuals differ in their willingness to pay for insurance with effort rewards. If that is the case, I show that menu pricing always leads to a socially inefficient amount of effort being exerted if all individuals prefer exerting effort. Thus, the observability of illness prevention can lead to a more efficient outcome but cannot remove the inefficiencies of the unobservability of risk type completely.

All in all, the three most important outcomes of the model are as follows. First, if risk type is observable and individuals differ in income, all individuals remain insured under both perfect competition and monopoly. Second, if risk type is unobservable, the observability of illness prevention can increase social welfare but cannot remove the inefficiencies of the unobservability of risk type completely. However, I show that this is only possible if individuals differ in their willingness to pay for insurance with effort rewards. Third, due to an increase in market power, the preferences of individuals may not be aligned with the preferences of the insurer regarding illness prevention which can lead to a socially inefficient amount of effort being exerted.

Coming back to the concerns regarding adverse selection described in the introduction, insurance with effort rewards can potentially be used by insurers to distinguish between risk types which can lead to higher premiums because the insurer can extract the whole surplus. Since risk types are divided into separate insurance contracts, this also reduces the level of risk spreading. From this, we can learn the concerns are legitimate and therefore the availability of such insurance should be considered carefully by insurers and governments.

For future research, I recommend diving deeper into the factors which determine whether an individual prefers exerting effort. In the model, individuals differ either in income or risk type, but in reality, factors such as motivation or influence from other individuals could also be very important in determining effort preferences. In addition, the motivation behind this paper came from the introduction of insurance with effort rewards on the Dutch health care market. In the Netherlands, health insurance is mandatory. I suggest studying the role of insurance with effort rewards when being insured is mandatory, to see if this influences the preferences of the individuals. Next to that, I recommend studying the relationship between effort in illness prevention and risk type. This way insurers will be more able to identify the risk type of an individual since they can observe effort. Finally, the model I constructed would ideally be tested with data to see whether theory and reality match.

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Appendix A: The Monopolist Insurer with a Taylor Expansion

Unfortunately, the Taylor expansion does not simplify a lot under a monopoly. Under perfect competition, the fact that $\pi = pm$ simplifies a large part of the equation. In the monopolistic situation, this is not the case anymore. When evaluating the utility function at net income including the surcharge s I get:

$$V_{N,m}^{ne} \approx (1-p)\left[U(y-pm-s) + U'(pm+s) + \left(\frac{1}{2}\right)U''(pm+s)^2\right] + p\left[U(y-pm-s) - U'(m-pm-s) + \left(\frac{1}{2}\right)U''(m-pm-s)^2\right]$$

Then, collecting terms:

$$V_{N,m}^{ne} \approx U(y-pm-s) + U'[(1-p)(pm+s) - p(m-pm-s)] + \left(\frac{1}{2}\right)U''[(1-p)(pm+s)^2 + p(m-pm-s)^2]$$

This simplifies to:

$$V_{N,m}^{ne} \approx U(y-pm-s) + U's + U'\left(\frac{U''}{2U'}\right)(\pi_m^{ne}(\pi_m^{ne} - 2pm) + pm^2)$$

I then calculate the value of insurance:

$$Value\ of\ Insurance\ without\ effort = \frac{(V_{I,m}^{ne} - V_{N,m}^{ne})}{U'} = -s + \left(\frac{1}{2}\right)\left(\frac{-U''}{U'}\right)(\pi_m^{ne}(\pi_m^{ne} - 2pm) + pm^2)$$

The consumer is indifferent between being insured and uninsured if:

$$-s + \left(\frac{1}{2}\right)\left(\frac{-U''}{U'}\right)(\pi_m^{ne}(\pi_m^{ne} - 2pm) + pm^2) = 0$$

I rewrite this equation as:

$$\left(\frac{1}{2}\right)\left(\frac{U''}{U'}\right)s^2 + s + \left(\frac{1}{2}\right)\left(\frac{-U''}{U'}\right)(pm^2 - p^2m^2) = 0$$

Using the quadratic formula, I get:

$$s = \frac{1 \pm \sqrt{1 + \left(\frac{-U''}{U'}\right)^2 (p^2m^2 - pm^2)}}{\left(\frac{-U''}{U'}\right)}$$

The individuals are assumed to be risk-averse, so the term $\left(\frac{-U''}{U'}\right)$ is positive. Since $s > 0$, the numerator must then also be positive. The discriminant under the square root term is greater than one, making the square root greater than one. Thus, only the plus sign in the numerator keeps the whole numerator positive:

$$s = \frac{1 + \sqrt{1 + \left(\frac{-U''}{U'}\right)^2 (p^2m^2 - pm^2)}}{\left(\frac{-U''}{U'}\right)}$$

Appendix B: Proof Situations 2, 3, 6 and 7 in Table 1

Proof Situation 2

In situation 2, the individual has the following preference when uninsured:

$$V_N^{ne} \geq V_N^e \tag{91}$$

And when insured:

$$V_I^{ne} \leq V_I^e \tag{92}$$

Here, I will prove such a situation is possible for certain values of t. For equation 91 to hold, we must have:

$$t > \frac{r^2 y_i{}^2 - r^2 m y_i + r^2 pmy - r y_i{}^2 + rm^2 - rpm^2 - m^2 + m y_i}{pm(y_i - m)} \tag{93}$$

For equation 92 to hold, using equation 15, we must have:

$$t < 1 - \frac{y_i(1-r)}{pm} \tag{94}$$

This means there is a solution for situation 2 if t is somewhere between equation 93 and equation 94. For this to be possible, we must have:

$$\frac{r^2 y_i{}^2 - r^2 m y_i + r^2 pm y_i - r y_i{}^2 + rm^2 - rpm^2 - m^2 + m y_i}{pm(y_i - m)} - \left(1 - \frac{y_i(1-r)}{pm}\right) < 0 \tag{95}$$

I rewrite the right-hand side of equation 94 as:

$$\begin{gathered} 1 - \frac{y_i(1-r)}{pm} = \frac{pm + r y_i - y_i}{pm} = \\ \frac{(pm + r y_i - y_i)(y_i - m)}{pm(y_i - m)} = \frac{pm y_i - pm^2 + r y_i{}^2 - rm y_i - y_i{}^2 + m y_i}{pm(y_i - m)} \end{gathered} \tag{96}$$

Then, I simplify equation 95:

$$\frac{r^2 y_i{}^2 + r^2 pm y_i + rm^2 + pm^2 + rm y_i + y_i{}^2 - r^2 m y_i - 2r y_i{}^2 - rpm^2 - m^2 - pm y_i}{pm(y_i - m)} < 0 \tag{97}$$

Since the denominator is always positive, I will now show for which values of r the numerator is also positive. First, I collect terms in the numerator:

$$\frac{r^2({y_i}^2 + py_im - my_i) + r(m^2 + my_i - 2{y_i}^2 - pm^2) + pm^2 + {y_i}^2 - m^2 - pmy_i}{pm(y_i - m)} \tag{98}$$

Using the quadratic formula, I solve the following equation:

$$r^2({y_i}^2 + py_im - my_i) + r(m^2 + my_i - 2{y_i}^2 - pm^2) + pm^2 + {y_i}^2 - m^2 - pmy_i = 0 \tag{99}$$

Note the LHS of equation 99 is a U-shaped parabola since ${y_i}^2 + pmy_i - my_i > 0$. Because this is a quadratic function, I get two solutions for r. The first solution for r is:

$$r = \frac{-m^2 - my_i + 2{y_i}^2 + pm^2 - m\sqrt{p^2m^2 - 2pm^2 + m^2 - 2y_im + 6py_im - 4p^2y_im + {y_i}^2 - 4p{y_i}^2 + 4p^2{y_i}^2}}{2({y_i}^2 + py_im - y_im)} \tag{100}$$

The second solution for r is:

$$r = \frac{-m^2 - my_i + 2{y_i}^2 + pm^2 + m\sqrt{p^2m^2 - 2pm^2 + m^2 - 2my_i + 6pmy_i - 4p^2my_i + {y_i}^2 - 4p{y_i}^2 + 4p^2{y_i}^2}}{2({y_i}^2 + pmy_i - my_i)} \tag{101}$$

Thus, situation 2 is possible if the following values hold for t and r:

$$RHS\ equation\ 93 < t < RHS\ equation\ 94 \tag{102}$$

$$RHS\ equation\ 100 < r < RHS\ equation\ 101 \tag{103}$$

Proof Situation 3

In situation 3, the individual has the following preference when uninsured:

$$V_N^{ne} \leq V_N^e \tag{104}$$

And when insured:

$$V_I^{ne} \geq V_I^e \tag{105}$$

Without loss of generality, I apply the same steps as in the proof of situation 2. Situation 3 is possible if the following values hold for t and r:

$$RHS\ equation\ 94 < t < RHS\ equation\ 83 \tag{106}$$

$$r < RHS\ equation\ 100\ or\ r > RHS\ equation\ 101 \tag{107}$$

Proof Situation 6

The monopolist insurer can offer a contract with or without a reward for effort. Suppose an individual has the following preferences when uninsured:

$$V_N^{ne} \geq V_N^e \tag{108}$$

Then, an individual prefers being insured insurance with effort rewards if:

$$V_I^e \geq V_N^{ne} \tag{109}$$

The willingness to pay for insurance with a reward for effort equals:

$$\frac{-y_i{}^2 + my_i + ry_i{}^2 - rmy_i + rpmy_i}{y_i - m + pm} \tag{110}$$

Next, the insurer will compare the profit margin of offering insurance with effort rewards to insurance without rewards (situation 5). The monopolist offers a contract with a reward for effort if:

$$\left(\frac{-\overline{y}^2 + m\overline{y} + r\overline{y}^2 - rm\overline{y} + rpm\overline{y}}{\overline{y} - m + pm} - tpm\right) - \left(\frac{pm\overline{y}}{\overline{y} - m + pm} - pm\right) > 0 \tag{111}$$

Thus, the monopolist offers insurance with rewards for effort for the following values of t:

$$t < \frac{r\overline{y}^2 - \overline{y}^2 + m\overline{y} - rm\overline{y} + rpm\overline{y} + p^2m^2 - pm^2}{pm(\overline{y} - m + pm)} \tag{112}$$

Proof Situation 7

The monopolist insurer can offer a contract with or without a reward for effort. Suppose an individual has the following preferences when uninsured:

$$V_N^{ne} \leq V_N^e \tag{113}$$

Then, an individual prefers being insured insurance with effort rewards if:

$$V_I^e \geq V_N^{ne} \tag{114}$$

The willingness to pay for insurance with a reward for effort equals:

$$\frac{-r^2y_i{}^2 + rmy_i + ry_i{}^2 - my_i + tpmy_i}{ry_i - m + tpm} \tag{115}$$

Next, the insurer will compare the profit margin of offering insurance with effort rewards to insurance without rewards (situation 5). The monopolist offers a contract with a reward for effort if:

$$\left(\frac{trpm\overline{y}}{r\overline{y}-m+tpm}-tpm\right)-\left(\frac{-r^2\overline{y}^2+rm\overline{y}+r\overline{y}^2-m\overline{y}+tpm\overline{y}}{r\overline{y}-m+tpm}-pm\right)>0 \tag{116}$$

Simplifying equation 116, this becomes:

$$\frac{r^2\overline{y}^2+r\left(-m\overline{y}-\overline{y}^2+pm\overline{y}\right)+m\overline{y}-tpm\overline{y}+tpm^2-t^2p^2m^2-pm^2+tp^2m^2}{r\overline{y}-m+tpm}>0 \tag{117}$$

For the LHS of equation 117 to be positive, either both the numerator and denominator must be positive, or both must be negative. There are two values r for which the numerator is equal to zero:

$$r=\frac{m+\overline{y}-pm-\sqrt{m^2(p^2+4t^2p^2-4tp^2+2p-4tp+1)+2m(2tp\overline{y}-p\overline{y}-\overline{y})+\overline{y}^2}}{2\overline{y}} \tag{118}$$

$$r=\frac{m+\overline{y}-pm+\sqrt{m^2(p^2+4t^2p^2-4tp^2+2p-4tp+1)+2m(2tp\overline{y}-p\overline{y}-\overline{y})+\overline{y}^2}}{2\overline{y}} \tag{119}$$

Since $\overline{y}^2>0$, the numerator of the LHS of equation 117 has a U-shape. Therefore, the numerator is positive if:

$$r<RHS\ equation\ 118\ or\ r>RHS\ equation\ 119 \tag{120}$$

And the numerator is negative if:

$$RHS\ equation\ 118<r<RHS\ equation\ 119 \tag{121}$$

The value of r for which the denominator of equation 117 is positive is:

$$r>\frac{m(1-tp)}{\overline{y}} \tag{122}$$

And the denominator is negative if:

$$r<\frac{m(1-tp)}{\overline{y}} \tag{123}$$

Thus, there are two possibilities for situation 7 to take place. The first solution is:

$$r < RHS\ equation\ 118\ or\ r > RHS\ equation\ 119\ and\ r > \frac{m(1 - tp)}{\bar{y}} \tag{124}$$

The second solution is:

$$RHS\ equation\ 118 < r < RHS\ equation\ 119\ and\ \ r < \frac{m(1 - tp)}{\bar{y}} \tag{125}$$

Appendix C: Intuition Equation 83

Equation 83 states the following:

$$\pi_m^e = V_{I,H}^e - V_{I,H}^{ne} + V_{\mathrm{I},L}^{ne} - V_{N,L}^e$$

The indifference premium of high-risk individuals for insurance with effort rewards can be written as:

$$V_{I,H}^e - V_{N,H}^e$$

Thus, high-risk individuals pay a lower premium under menu pricing compared to one price targeted at them if:

$$V_{I,H}^e - V_{N,H}^e > V_{I,H}^e - V_{I,H}^{ne} + V_{\mathrm{I},L}^{ne} - V_{N,L}^e$$

Rewriting, this is the case if:

$$V_{I,H}^{ne} - V_{N,H}^e > V_{\mathrm{I},L}^{ne} - V_{N,L}^e$$

Whether the inequality above holds, depends on the difference in effort costs between the two risk types. For example, if effort costs are low for high-risk individuals, the insurer can charge a higher premium for the insurance with effort rewards. Thus, with a decrease in effort costs for high-risk individuals, the premium moves towards their indifference premium.