When prices hardly matter: Incomplete insurance contracts and markets for repair goods[†]

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Abstract

This paper looks at markets characterized by the fact that the demand side is insured. In these markets a consumer purchases a good to compensate consequences of unfavorable events, such as an accident or an illness. Insurance policies in most lines of insurance base indemnity on the insured's actual expenses, i.e., the insured would be partially or completely reimbursed when purchasing certain goods. In this setting we discuss the interaction between insurance and repair markets by focusing, on the one hand, upon the development of prices and the structure of markets with insured consumers, and, on the other hand, the resulting backlash on optimal insurance contracting. We show that even in the absence of ex post moral hazard the extension of insurance coverage will lead to an increase in prices as well as to a socially undesirable increase in the number of repair service suppliers, if repair markets are imperfect.

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1. Introduction

This paper is concerned with markets characterized by the fact that the demand side is insured. In these markets, which will be referred to as *repair markets*, a consumer purchases a good or repair service to compensate consequences of certain unfavorable events, such as an accident or an illness. Examples are segments of the markets for car repair services and rental cars as well as the markets for medical services and pharmaceutical products.

The fact that consumers are insured, would by itself not cause economic problems so long as insurance companies are able to write complete contingent contracts assigning indemnity payments directly to any possible "state of the world". Typically, though, the set of potential states of the world is rather complex implying that writing complete contracts would either be impossible or cause disproportionate transaction costs.[1] For example, a complete contract in auto insurance would have to precisely define the indemnity payable in case of any possible damage to the involved automobiles. As the latter is usually not a realistic option, insurance policies in most lines of insurance base indemnity on the insured's actual expenses, i.e., the insured would be partially or completely reimbursed when purchasing certain goods.

In perfect repair markets the fact that consumers are insured would have no impact on the actual prices, since prices correspond to marginal cost. However, as empirical work, e.g. by *Feldstein* (1970), *Zweifel* and *Crivelli* (1996), *Pavcnik* (2002) and *Finkelstein* (2007) suggests, insurance design has a major impact upon repair markets. Therefore, it is intuitive to suppose that repair markets are imperfect since prices usually exceed marginal costs. A straightforward rationale for the latter is market power which can result from heterogeneous preferences or tastes.

[1] See, for example, *Anderlini* and *Felli* (1994), *Segal* (1999), *Maskin* (2002).

For the single consumer, transaction costs incurred in the process of consuming repair goods often differ across suppliers, for instance depending on the location of suppliers relative to the consumer. In the context of car repair shops or rental cars, an illustration of this can be seen in spatial preferences. Another example can be observed in markets for pharmaceutical products and health services, where market power results from consumers' designated preferences for certain suppliers. Given such preferences, it is an important task to analyze the implications of insurance for consumers' demand decisions in imperfect repair markets.

If repair markets are imperfect and consumers are insured, prices of repair goods are directly affected by insurance arrangements. Consequently, an extension of coverage will lead to increasing prices for repair goods. Note that this line of argument is valid even in the absence of any ex post moral hazard problems: Consider a situation where coverage is based upon consumers' expenses and insurance companies are able to effectively control quality of repair goods purchased. In such a situation consumers' product choice will also be less price sensitive and will therefore lead to a price increase if they have certain preferences among suppliers.

The existing related empirical literature, which for the most part addresses the demand for health care and pharmaceutical products, is extensive. Several studies by *Feldstein* show that physicians in medical markets raise their fees and improve their products when insurance coverage becomes broader, and even non-profit hospitals respond to an increase in insurance by increasing the sophistication and the price of their services (*Feldstein* 1970, 1971). More importantly and probably somewhat puzzlingly at first glance, empirical analysis indicates that a reduction of the actual demand for insurance coverage would induce a welfare gain, i.e. individuals purchase too much insurance (*Feldstein* 1973, the issue was revisited, e.g., by *Feldman* and *Dowd* 1991). This is surprising, as one would expect that working insurance markets provide the optimal amount of coverage even in the presence of moral hazard. In particular, the existence of ex post moral hazard can not explain why insurance companies offer insurance contracts with more coverage than the socially desirable amount. Given the above mentioned empirical findings *Feldstein* suggests that the over-insurance result is due to a prisoner's dilemma, as "People spend more on health because they are insured and buy more insurance because of the high cost of health care".[2] One of the goals of this paper is to provide a theoretical explanation for this finding by showing that companies in competitive insurance markets will face an externality problem if repair markets are imperfect and insurance contracts are incomplete. Therefore, the risk allocation and the price increasing effects of insurance coverage are suboptimally balanced, and subsequently, insurance contracts entail too much coverage.

In a recent paper, *Pavcnik* (2002) analyzes how a reduction of insurance coverage in the German statutory health insurance influences pharmaceutical product prices. Prior to 1989 expenses for prescription pharmaceuticals in the German statutory health insurance were virtually entirely covered.[3] In 1989, a reference pricing scheme for certain drugs with identical active substances was introduced. The particular reference prices represented a maximum reimbursement for insureds. Therefore, if the retail price of a pharmaceutical product exceeded the references price, the patient would have to bear the excess costs. Since the German statutory health insurance market covers over 90% of the population, *Pavcnik*'s study illustrates the impact of insurance on prices for pharmaceutical products by showing that retail prices for drugs

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[2] *Feldstein* (1973), p. 252.

[3] Insureds only had to pay a fixed co-payment of 3 Deutsch Marks per prescription. Despite the lack of cost-sharing by patients, prices for pharmaceutical products prior to 1989 were not exorbitant. This counterintuitive result can be explained by the fear of future price regulation for suppliers of pharmaceutical products. For further details, see *Zweifel* and *Crivelli* (1996).

decrease considerably as patients' out-of-pocket expenses increase. *Pavcnik*'s estimates of price adjustments to exogenous change in insurance reimbursement range from 10% to 26%. These changes in prices for pharmaceutical products can hardly be explained entirely via ex post moral hazard.

The studies of *Manning* et al. (1987), *Newhouse* (1992) and *Newhouse et al.* (1993) used the Rand Health Insurance Experiment (RHIE) in 1974 in which in total 5,807 persons were assigned to different insurance plans to estimate the impact of health insurance on health spending and patients' behavior. The authors found that patients with full insurance coverage used significantly more health care than those who had to co-pay directly. Furthermore, these studies suggested that cost sharing affected primarily the number of medical contacts. Therefore, *Manning* et al. conclude that "the differences in expenditures across plans reflect real variations in the number of contacts rather than an increase in the intensity or charge per service."[4] Consequently, the RHIE seemingly suggest that the impact of health insurance on health spending are not that much important as *Feldstein*'s studies had estimated. By considering the introduction of Medicare in the United States, *Finkelstein* (2007) revisits this debate and points out that the spread of health insurance may have played a much larger role in the rise of health spending than the RHIE would suggest.

The implementation of Medicare which provided virtually universal public health insurance to individuals aged 65 and older constituted the single largest change in health insurance in the American history. Among other things, *Finkelstein* estimates that Medicare reduced the average coinsurance rate in the population by about 7 percent and had a significant effect on market entry in the hospital market. In the first five years after the reform, the Medicare-induced entry in the

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4 *Manning* et al. (1987), S. 258.

hospital market was responsible for about half of the overall 37 percent increase in total spending. Extrapolating from this relationship in the hospital sector implies that the 50 percentage point decrease in coinsurance rates between 1950 and 1990 would only be able to explain about half of the six-fold rise in real per capita health spending in the United States over this period of time. More importantly, her study suggests that, in its first five years, the introduction of Medicare was associated with an increase in spending that was over six times larger than what the estimates from the RHIE would have predicted.

As *Finkelstein*'s analysis only regards hospital expenditures on inputs, and does not consider hospital output prices, she purely estimates the increase in health care spending caused by ex post moral hazard. Consequently, the other half of the six-fold rise in per capita health spending in the time period from 1950-1990 remains unexplained. One of the basic insights of the *Finkelstein* paper which the author stresses is that *market-wide* changes in health insurance can fundamentally change the nature and character of medical practice in ways that small-scale changes will not. In this spirit, our paper suggests that apart from problems of ex post moral hazard, the market-wide introduction of incomplete insurance contracts fundamentally changes the behavior of suppliers in imperfectly repair markets.

Surprisingly, only few theoretical papers so far have dealt with the interdependencies between insurance and repair markets. *Frech* and *Ginsburg* (1975) address the question of how, in a monopolistic health care market, different types of insurance benefits affect price and quantity. They find, among other results, that in any case both parameters will increase, with prices tending to infinity for the case of complete insurance. However, since, e.g., the markets for medical services or car repair services typically have an oligopolistic or atomistic structure, the results of *Frech* and *Ginsburg* do not capture the situation in most of the repair markets and particularly the externality problem we are interested in. *Gaynor et al.* (2000) analyze the interdependence between the degree of competition in health care markets and the extent of excess consumption due to insurance by assuming exogenous pricing of health care providers. Their results indicate that, even though it is intuitively appealing that imperfect competition in health care markets may constrain excessive consumption of health care services, consumers actually benefit from increased competition in health care markets. *Chiu* (1997) first formalized the proposition of *Feldstein* (1970) that the value of health insurance may be overcompensated by the negative impact of the resulting price increase in the repair market. He shows that if the supply of health care is completely inelastic, health care price inflation completely destroys the value of any insurance indemnity. Consequentially, consumers' welfare could be increased by means of decreasing insurance coverage. *Vaithianathan* (2006) shows that *Chiu*'s results hold if instead of completely inelastic supply *Cournot* competition is assumed for the health care market. For a monopolistic health care market, *Wigger* and *Anlauf* (2007) demonstrate that, starting from equilibrium, a reduction of insurance coverage increases consumers' welfare but reduces overall social welfare. This is due to the fact that the ex post moral hazard associated with insurance counteracts the low consumption in a monopolistic repair market.

Our paper differs fundamentally from the ones mentioned with respect to the following aspects:

- We are concerned with an imperfect repair market with price competition. For most repair markets, this assumption strikes us as more adequate than *Cournot* competition or a monopoly.
- The approach employed in this paper, allows us to derive unambiguous results regarding the effects on social welfare both in the insurance and the repair market.

- The most important difference, however, can be seen in the fact that in this model price effects are not caused by ex post moral hazard. Thus, it can be shown that insurance coverage induces greater prices for repairs even if the amount of repair services purchased does not depend on the consumers' level of coverage.

The reason why the interaction between insurance and repair markets has not yet been studied more extensively from a theoretical point of view presumably can be seen in the typical perception of insurance in the economics literature: Insurance contracts are usually interpreted as a specific kind of financial contract, in which the insured – in return for the premium – acquires a claim upon future state-contingent payments. Most precisely, this has been stated by Arrow: "insurance is the exchange of money now for money payable contingent on the occurrence of certain events"[5]. According to this view, insurance contracts are considered complete in the sense that the amount of indemnity can be directly tied to the occurrence of states of the world. However, as has been stated above, this is not what we observe in important lines of insurance, where the insured, in case of a loss, receives coverage based upon his or her actual repair expenses. Therefore, these insurance contracts are incomplete, as the insurer's payments are not unambiguously given and, in particular, depend on the prices for repair services.

In this paper, we discuss the interaction between insurance and repair markets by focusing, on the one hand, upon the development of prices and the number of suppliers in markets with insured consumers, and, on the other hand, the resulting backlash on optimal insurance contracting. To keep things as simple as possible, we assume that no information asymmetries exist and that insurance is available at actuarially fair premiums. Frictions, however, exist in the repair market. We consider a repair market with product differentiation which provides the single

[5] *Arrow* (1965), p. 45.

supplier with a certain spatial market power. The model framework employed here is based upon an approach introduced by *Salop* (1979). Basically, the focus is on indescribable contingencies in insurance arrangements. We are interested in the impact of incomplete insurance contracts on imperfect repair markets. As the introduction of incomplete contracts means a substantial imperfectness and because our analysis is supposed to concentrate on this problem, we will mainly abstain from other imperfections, especially any ex post moral hazard problems in insurance markets (*Pauly*, 1968). However, the effect of ex post moral hazard on our results will be addressed when the impact of insurance on the outcome in the repair market is discussed.

We also study a problem concerning the optimal structure of insurance markets: A pareto-efficient insurance contract maximizes consumers' expected utility under certain constraints. The main task for the insurer in the considered context is to balance the trade-off between risk allocation and the insurance-induced price effect in the repair market. But the limiting effect of a coinsurance rate on the repair market price level depends on the market share of the offering insurance company. In an atomistic market a single insurer's contract design only has a negligible impact on the repair market and its price level. Consequently, the equilibrium coinsurance rate will increase in the market share of a particular insurer or decrease in the number of insurance companies respectively. Thus, insurance companies are indeed facing a prisoner's dilemma problem as suggested by *Feldstein*.

The remainder of the paper is organized as follows. Section 2 introduces the model. In section 3 we present benchmarks for the following analysis. Section 4 discusses the impact of incomplete insurance contracts on the structure of the repair market and refers to the impact of ex post moral hazard, while section 5 addresses effects in the insurance market. Section 6 deals with the externality problem in competitive insurance markets and section 7 concludes.

2. The model framework

The analysis focuses on the optimal insurance design and the number of firms in repair markets with insured consumers. We assume that consumers have heterogeneous preferences. These preferences are interpreted as being caused by consumers' spatial distribution. We consider n suppliers, denoted $j = 1,...,n$ that offer a good respectively a repair service. Each company offers a repair service at the price p_j and the suppliers compete in prices. The cost associated with providing one unit of the repair service is $c \geq 0$. Consumers with an initial wealth of w_0 face the risk of a loss with probability $\pi \in (0,1)$. In case of a loss suppliers offer one repair unit, which fully restores the loss, but consumers face transportation cost of t per unit of the distance x to the supplier. The model framework is based upon the circular city model by *Salop* (1979), where consumers are uniformly and continuously distributed along a circle with a perimeter of $1/\pi$ and a density A.[6] We normalize $A = 1$ for uninsured consumers. Consumers have a twice-differentiable utility function $u(w)$ with $u'(\cdot) > 0, u''(\cdot) < 0$, where w represents the final wealth of consumers. Thus, consumers' preferences are only heterogeneous with respect to the repair good. In the insurance market m risk-neutral insurers, denoted $i = 1,...,m$, simultaneously offer contracts $C_i = (\alpha_i, I_i)$ which consist of an indemnity $I_i = (1 - \delta_i) p_j$, where $\delta_i \in [0,1]$ denotes the individual contract's coinsurance rate, and an actuarially fair break-even premium $\alpha_i = \pi I_i$.[7]

We further assume that uninsured consumers suffering from a loss prefer to repair the damage and that exactly one repair unit is necessary. Through these assumptions we abstain from

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[6] Usually, the perimeter in the *Salop* model is normalized to one. Our ex ante normalization of $1/\pi$, where π is the probability of a loss, implies that the ex post size of the repair market, after the realization of losses, is one.

[7] To make things as simple as possible, we do not model the price competition between insurance companies explicitly and only consider that every single insurance contract leads to zero expected profits.

the problem of ex post moral hazard, as the extent of purchased repair services is independent of the amount of coverage. Consequently, $A = 1$ holds even for insured consumers. This is plausible in situations where only one repair unit is necessary and over-consumption has no value for consumers. Assuming that uninsured consumers derive a surplus from purchasing the repair service implies that insured consumers with an insurance contract C_i strictly prefer to purchase the service in case of an accident. Ex post moral hazard will only be introduced in our model in section 4 by assuming that $A = A(\delta)$ with $A(1) = 1$ and $\frac{\partial A}{\partial \delta} < 0$.[8]

The sequence of the considered game between insurers, consumers and suppliers is as follows: At stage 1, each of the m insurance companies simultaneously offers a break-even insurance contract C_i. Then at stage 2, the potential entrants in the repair market simultaneously choose whether or not to enter the market. Suppliers that entered are equidistantly distributed on the circle.[9] As we analyze the problem of the number of suppliers entering the market, we assume that the potential entrants face fixed entry costs of $f > 0$. Because of the free entry assumption the equilibrium profit of entering firms is zero. Finally, at stage 3 the suppliers that have entered set their prices p_j, given their locations.

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[8] The effects of an increasing density were first analyzed by *Riordan* (1986) within a context of repeated purchases.

[9] *Economides* (1989) shows in a three stage Salop model with endogenous product differentiation that entering firms locate equidistantly.

3. Social optima

As a reference point for the following analysis, we take a look at different benchmark situations. Let us first start with situations where complete insurance contracts are feasible. These contracts and the associated indemnity can be conditioned upon any possible state of nature. Under such ideal circumstances the optimal insurance arrangement is straightforward: since insurance companies can anticipate the (equilibrium market) price for a repair unit, the indemnity corresponds to the equilibrium price and the resulting transportation cost of each consumer.

First-Best

The first-best insurance contract (a) entails optimal risk allocation and (b) minimizes the sum of standing expenses and consumers' transportation cost:[10]

$$\min_n \left[nf + 2tn \int_0^{\frac{1}{2n}} x \, dx \right]. \tag{1}$$

The solution is characterized by the following conditions:

(a1) $I_i = p^{FB} + tx$ with $p^{FB} = c + 2\sqrt{tf}$ and

(b1) $n^{FB} = \frac{1}{2}\sqrt{\frac{t}{f}}$.

One of the main results of the *Salop* model is that in equilibrium too many suppliers enter the repair market. Thus, requirement (b) is not met, if repair and insurance market are

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[10] For further details concerning the determination of first and second-best prices as well as the associated numbers of suppliers see *Salop* (1979).

independent. However, when the structure of the repair market is endogenous, vertically integrating the repair market can potentially lead to a first-best situation. By overriding the *Salop* competition in the repair market insurance companies can reduce the number of operating repair service suppliers. A monopoly insurer or a coalition of all insurance companies can establish a repair service network with a first-best number of repair shops, and consumers are fully compensated for any losses.

Second-Best

In a second-best situation, complete insurance contracts are still feasible, but due to legal or other restrictions, insurance companies are not able to enforce structural actions which influence or offset the competition in the repair market. Thus, the second-best is characterized by the following condition:

(a2) $I_i = p^{SB} + tx_i$ with $p^{SB} = c + \sqrt{tf}$ and

(b2) $n^{SB} = \sqrt{\frac{t}{f}}$.

As in the first-best framework, risk allocation is still first-best. However, as has been shown by *Salop*, in equilibrium too many suppliers enter the market. This leads to a welfare loss compared to the first-best situation.

Third-Best

A further welfare loss is incurred when insurance contracts are incomplete. The optimal incomplete insurance contract trades off the insurance-induced price effect on the repair market and risk allocation. We will derive and characterize the third-best insurance contract in the following two sections.

4. Effects in the repair market

Starting with the price competition at stage 3, we assume that n suppliers have entered the market. In this situation, consumers decide upon deterministic outcomes and only those who suffered a loss purchase the repair unit. We assume in the first instance that all consumers accepted the same incomplete insurance contract with a strictly positive coinsurance rate $(\delta > 0)$.[11] Subsequently, we concentrate on symmetric equilibria, where all suppliers charge the same price p.

Lemma

For any strictly positive coinsurance rate $\delta \in (0,1)$, *the number of operating service suppliers in a symmetric equilibrium* $n^* = \sqrt{\frac{t}{\delta f}}$ *is greater than the first-best and the second-best optimum as* $n^* > n^{SB} > n^{FB}$. *Insurance coverage also increases prices in the repair market compared to the second-best:* $p^* = c + \sqrt{\frac{tf}{\delta}} > p^{SB}$.

Proof: See Appendix

The case of uninsured consumers refers to $\delta = 1$. Thus, insurance with $\delta < 1$ leads to an increase in the number of suppliers as well as in the market price. The intuition behind these results is straightforward: With decreasing δ the repair service suppliers' market power and therefore their profits increase. The rising profits attract additional entrants and reduce, therefore, the segment size $1/n$ covered by an individual supplier. Firms enter the market until expected profits equal zero. The increased competition caused by additional market entries attenuates the

[11] In section 5 it will be shown that $\delta = 0$ can never be a part of an equilibrium.

rise in price but does not prohibit it. With the increasing number of suppliers total standing expenses grow and thus, given a constant demand, the zero-profit constraint can only be fulfilled at a higher price level. In other words, insurance arrangements diminish consumers' price sensitivity and increase suppliers' market power. This makes repair markets more attractive for entrants and further increases the already socially undesirable high number of suppliers.

Excursion on the impact of ex post moral hazard

As most papers which analyze the interaction of insurance and repair markets stress the importance of ex post moral hazard, we briefly discuss the impact of ex post moral hazard on the outcomes in the repair market. In our model ex post moral hazard can be incorporated by assuming that in case of a loss some uninsured consumers are better off without repair service or by assuming that consumers derive a positive marginal net benefit from purchasing more than one repair unit. Both assumptions result in an increase in the density A, when consumers are insured. Therefore, we assume $A = A(\delta)$ with $A(1) = 1$ and $\frac{\partial A}{\partial \delta} < 0$.

Following the proof of our Lemma we derive:

$$n^*(A) = \sqrt{\frac{At}{\delta f}} \text{ and } p^*(A) = c + \sqrt{\frac{tf}{A\delta}} .$$

An increased demand caused by ex-post moral hazard $(A > 1)$, ceteris paribus leads to additional market entries compared to a situation without ex post moral hazard $(A = 1)$. Although the first-best-number $n^{FB}(A) = \frac{1}{2}\sqrt{\frac{At}{f}}$ of suppliers also increases in A [12], ex post moral

[12] See *Riordan* (1986), p. 268f.

hazard negatively affects social welfare as $\frac{\partial n^*}{\partial A} > \frac{\partial n^{FB}}{\partial A}$ holds for all δ and A. Thus, beyond the incomplete contract problem, ex post moral hazard results in an additional welfare loss as the increase in the equilibrium number of suppliers always exceeds the increase in the first-best number. Our results are in this respect in line with the findings of *Gaynor* et al. (2000). In both papers, the introduction of a second distortion results in a further decrease in social welfare: In *Gaynor* et al. an increase in prices due to imperfect competition magnifies welfare losses caused by moral hazard, while in our paper the introduction of ex post moral hazard increases welfare losses triggered by imperfect competition in repair markets and incomplete insurance contracts.

The impact of ex post moral hazard on prices is also very interesting: Surprisingly, for a given coinsurance rate prices in the repair market are lower in a situation with ex post moral hazard. The rationale for this result is that ex post moral hazard leads to additional market entries and intensifies competition in the repair market. This intensified competition reduces the increase in prices due to insured consumers. Our result is in contrast to the standard literature on moral hazard, where ex post moral hazard is the reason for higher prices for repair goods. Moreover, if the increase in demand due to ex post moral hazard is rather strong $\left(A(\delta^*) \cdot \delta^* > 1\right)$, one obtains the remarkable result that the price level in a repair market with insured consumers is even lower compared to a situation without any insurance.[13] In respect to the empirical literature, this limiting effect of ex post moral hazard can potentially explain the partly insignificant price increases in real repair markets.

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[13] However, such an increase in demand seems to be rather unlikely for repair goods.

5. Effects in the insurance market

Now we are able to determine the third-best insurance contract. Due to the complexity of the states of nature, insurers are assumed to be unable to fully specify the behavior of consumers and suppliers in the case of a loss. Consequently, insurance contracts can only be conditioned upon the consumer's expenses for the repair good. We further assume transportation costs to be uninsurable.

The third-best insurance contract maximizes the expected utility of an average consumer under the constraint that insurance contracts break even. The optimal insurance contract and in particular the coinsurance rate δ^{TB} trades off the insurance-induced price effect and risk allocation. Therefore, δ^{TB} is specified by the following expected utility maximization problem:

$$\max_{\delta} \quad EU(\delta) = (1-\pi)\, u\left(\underbrace{w_0 - \pi(1-\delta)\left(c + \sqrt{\frac{tf}{\delta}}\right)}_{:=w_n} \right) + \pi\, u\left(\underbrace{w_0 - \pi(1-\delta)\left(c + \sqrt{\frac{tf}{\delta}}\right) - \delta\left(c + \sqrt{\frac{tf}{\delta}}\right) - \frac{1}{4}\sqrt{\delta tf}}_{:=w_l} \right). \tag{2}$$

The first order condition for an interior solution is given by

$$\frac{\partial EU}{\partial \delta} = (1-\pi)\pi\, u'(w_n)\left[\left(c + \sqrt{\frac{tf}{\delta^{TB}}}\right) + \frac{1}{2}\left(1-\delta^{TB}\right)\sqrt{\frac{tf}{\left(\delta^{TB}\right)^3}}\right] + \pi\, u'(w_l)\left[\pi\left(c + \sqrt{\frac{tf}{\delta^{TB}}}\right) + \frac{1}{2}\pi\left(1-\delta^{TB}\right)\sqrt{\frac{tf}{\left(\delta^{TB}\right)^3}} - \left(c + \sqrt{\frac{tf}{\delta^{TB}}}\right) + \frac{1}{2}\delta^{TB}\sqrt{\frac{tf}{\left(\delta^{TB}\right)^3}} - \frac{1}{8}\sqrt{\frac{tf}{\delta^{TB}}}\right] = 0 \tag{3}$$

The following two propositions characterize the third-best insurance contract.

Proposition 1

A third-best optimal insurance contract can not entail full coverage $\left(\delta^{TB} > 0\right)$.

Proof: See Appendix

The intuition for Proposition 1 is straightforward: The optimal insurance contract trades off the benefit of an improved risk allocation and the costs of the insurance-induced price effect. On the one hand, the marginal benefit from improved risk allocation due to an additional increase in insurance coverage is decreasing in coverage and diminishes if consumers are fully insured. On the other hand, the marginal price effect is strictly increasing in coverage and tends to infinity as the coinsurance rate tends to zero. Consequently, the third-best contract cannot provide full insurance.[14]

Now we turn to the question of whether the optimal insurance contract entails any coverage at all ($\delta^{TB} < 1$).

Proposition 2

If consumers are sufficiently risk-averse, the third-best contract entails partial insurance $\delta^{TB} \in (0,1)$. *Otherwise the third-best contract does not provide any coverage* $\left(\delta^{TB} = 1\right)$.

Proof: See Appendix

Starting from the point where consumers are initially uninsured, a marginal increase in coverage increases the price for a repair unit and decreases transportation costs due to additional entries in the repair market. However, the overall costs for consumers are increasing, since the

[14] Our general result regarding partial insurance still holds in a situation in which insurance companies are risk-averse. In this case full insurance would not be optimal anymore with respect to the optimal risk allocation. Therefore, insurer's risk-aversion would further increase the equilibrium coinsurance rate.

price effect outweighs the transportation costs effect. Thus, consumers are only better off with insurance coverage if the benefit from improved risk allocation exceeds the increase in total costs. The benefit of risk allocation depends on the degree of consumers' risk aversion and therefore weakly risk-averse consumers prefer to stay uninsured.

Our results are mainly in line with standard moral hazard models like *Shavell* (1979). Optimal contracts derived from the latter model framework generally entail only partial coverage, due to a trade-off between risk allocation and appropriate loss prevention incentives. However, three important features distinguish our results from those of standard moral hazard models: First of all, in a moral hazard context the limitation of insurance coverage is a result of asymmetric information and reduced carefulness of policyholders. In our model it is only due to incomplete insurance contracts and the associated coverage-induced increase in prices. Secondly, the fact that weakly risk-averse consumers in our model may prefer to stay uninsured is in contrast to results from standard moral hazard models where risk-averse consumers always prefer to purchase some insurance coverage. Starting from a position of no coverage, in standard moral hazard models insurance does not affect policyholders' incentives at the margin. In contrast, in our model a marginal increase of coverage has a first order effect which is due to a coverage-induced price increase. Finally, and probably most importantly: At first glance, one would expect the contracting parties (in a moral hazard setting) to agree at least upon a second-best optimal insurance contract. In our model this is generally not the case, as the offered coinsurance rate considerably affects the market price for the repair service and therefore has an impact on other insurance arrangements. Hence, each individual insurer faces an externality problem, which we will tackle in the next section.

6. Market structure and externalities in the insurance market

In what follows we assume that an interior solution with $\delta^{TB} \in (0,1)$ exists. Optimal insurance contracts in standard moral hazard models efficiently solve the incentive problem between the two contracting parties and do not have any impact on other insurance arrangements. However, in the problem studied here each individual incomplete insurance contract affects the market price for the repair service and therefore the optimal contracting in other insurance relationships, as the following proposition illustrates.

Proposition 3

The equilibrium coinsurance rate δ^* *increases strictly in the market share of insurance companies.*

Proof: See Appendix

The capability to reduce the price effect in repair markets induced by insured consumers declines in the number of insurers, as the fraction of the market affected by a single insurer's coinsurance rate variation decreases. Consider an atomistic market structure. In this situation, insurance contracts offered by a single insurer have a negligible impact on the price level in the repair market. Therefore, in a competitive insurance market with $m \geq 2$ a problem of externalities arises and the symmetric Nash equilibrium in which all insurance companies split the market equally is not even third-best. The difference between the equilibrium coinsurance rate δ^* and δ^{TB} is the greater the higher the number of insurers. In this sense, a reduction of coverage in a competitive insurance market improves welfare. Thus, by explicitly considering externality problems in competitive insurance markets our model provides a theoretical explanation for *Feldstein*'s empirical results.

Given the externality problems associated with incomplete insurance contracts, the question arises how this externality should be addressed. Considering our results, one obvious solution might be an insurance monopoly.[15] A monopoly insurer completely takes the impact of the level of coverage on the repair market price level into account and, thus, offers contracts that entail a coinsurance rate δ^{TB}. Obviously, however, a monopoly is a strong market intervention that would be associated with major additional issues that may negatively affect welfare. Particularly, the socially desirable rent distribution would have to be implemented. For instance, authorities could regulate prices implying the insurer charges only actuarially fair premiums. However, it is important to stress that a monopoly insurer does not face any externality problems, but in an insurance monopoly at best only a third-best situation can be reached. For this reason, an intervention in the repair market may be desirable from a social planner's point of view.

Taking the problems associated with incomplete insurance contracts into account, only institutional arrangements can increase welfare beyond a third-best situation. Especially the vertical integration of insurance and repair markets may be an appropriate approach. In this respect, a variety of solutions are generally possible. An insurer or a coalition of more than one insurer could itself offer certain repair goods. In this case the coverage induced increases in prices as well as in the number of suppliers in the repair market can be avoided and a first-best could theoretically be reached.[16] Vertical integration is, e.g., fairly well-developed in the

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[15] In other contexts authors also have recently argued that insurance monopolies for certain areas achieve better results than competitive markets. See, for instance, the empirical findings by *Ungern-Sternberg* (1996) for the case of homeowner's insurance and the discussion of interdependent security problems by *Kunreuther and Heal* (2003). However, as noted by *Bonato* and *Zweifel* (2002), monopoly insurers in a moral hazard context may mandate an excessive level of loss prevention. Therefore, other effects limit the superiority of such an insurance market structure.

[16] Vertical integration can also be a powerful tool against ex post moral hazard.

American health insurance market (Managed Care), while in the European health sector as well as in auto insurance it can only be observed in its infancy.

Furthermore, contractual arrangements between insurance companies, suppliers and consumers which directly specify conditions under which repair goods are provided and which more importantly also limit consumers in choosing their repair service supplier may also increase welfare beyond the third-best situation. However, this kind of arrangement will obviously result in higher transportation costs for a given number of repair service suppliers if insurance companies do not contract with every supplier in the market. Furthermore, under such an institutional arrangement the same contractual problems associated with the complex set of potential states of the world may arise as in the contractual problem between insurance companies and consumers.

7. Conclusion

In numerous lines of insurance, such as, for instance, health or auto insurance, indemnities are based on the actual extent of repair services the insured purchases. Insurance coverage of this kind, however, has a major impact upon associated repair markets if the latter are not perfect: Even without any ex post moral hazard, the price level for repair services as well as the number of suppliers increase. The rising price level again affects the optimal insurance contract design, since even in perfect insurance markets with complete information an optimal contract would assign a share of the loss to the insured. It cannot be expected, though, that insurers in a competitive market offer optimal contracts, as the price increase induced by insurance coverage would not occur only for the single insurer but affects all insurers in the market. This means that an externality exists. Therefore, insurers will offer contracts with less coinsurance and thus more coverage than socially desirable.

In the light of our incomplete contract argumentation, our model setup seems to oversimplify reality, as we only consider one type of loss. However, we have to keep in mind that real insurance contracts apprehend a great variety of losses. Therefore, contracts conditioned upon each state of the world or each possible loss can hardly be written. Even if any kind of lump-sum compensation for certain losses which would reduce price effects in the repair market is socially desirable, it will hardly be feasible in most lines of insurance.

Naturally, we had to leave important aspects for future research. From our point of view, the following problems could be rather interesting topics to be tackled:

- We assume that the product space is completely homogeneous. This means that no product is a priori better than the other. This assumption seems adequate e.g. for auto insurance, since consumers' preferences for repair services are mainly determined by availability and convenience. On the other hand, in the health market context, patients would often have predetermined preferences for certain pharmaceutical products, as in particular copyright-protected products. It therefore seems fruitful to also look at repair markets with heterogeneous product spaces.
- In this paper, the assumption has been used that the insured is also the consumer for the repair service. But this is not useful to characterize liability insurance where the victim, who has a claim against the insured, purchases repair services. The victim usually has a legal right to be fully compensated, such that in liability insurance the impact on repair markets should be even more significant.
- When insurers cannot write complete contracts and, thus, the price level of repair services rises, a vertical integration of insurance and repair markets seems a straightforward

approach. For this reason, the introduction of vertical integration seems to be an important extension of this analysis.

Appendix

Proof of Lemma

Each firm has only two surrounding competitors. In order to derive a single supplier's demand function, let us consider supplier j. A consumer located between supplier j and one of its neighbors (offering a repair unit at the price p) at the distance $x \in [0,1]$ from supplier j is indifferent between the two competitors if

$$\delta p_j + tx = \delta p + t\left(\frac{1}{n} - x\right) \qquad (4)$$

holds.

To highlight the effects of insured consumers on the structure of repair markets, we rewrite (4) as

$$p_j + \frac{t}{\delta} x = p + \frac{t}{\delta}\left(\frac{1}{n} - x\right). \qquad (5)$$

The transportation cost rate t indicates the suppliers' market power, as it determines to what extent prices of repair services can exceed marginal cost. If a consumer is insured and, thus, δ is below one, the market power of repair firms is increased.

The resulting demand function of supplier j is given by

$$D_j(p_j, p) = 2x = \frac{1}{n} + \frac{\delta(p - p_j)}{t}. \qquad (6)$$

Each firm j maximizes its profit function

$$\max_{p_j} \quad \Pi_j(p_j, p) = (p_j - c)\left(\frac{1}{n} + \frac{\delta(p - p_j)}{t}\right) - f\,, \tag{7}$$

where c denotes the per-unit cost of providing the repair good. The first order condition for a profit maximum in a symmetric equilibrium with $p_j = p$ is

$$p = c + \frac{t}{\delta n}\,. \tag{8}$$

The price level in the repair market decreases in the number of entering firms and in the coinsurance rate. The number of entering firms is therefore endogenously determined by the zero profit constraint

$$\Pi_j(p) = \frac{t}{\delta n^2} - f = 0\,. \tag{9}$$

In the context of free market entry the number of firms in equilibrium is given by

$$n^* = \sqrt{\frac{t}{\delta f}}\,. \tag{10}$$

Even without insurance, the number of suppliers in market equilibrium n^* is too high compared to the first-best situation. Given a strictly positive coinsurance $\delta > 0$, the number of operating service suppliers is higher than the first and the second-best optimum (*Salop*, 1979), $n^* > n^{SB} > n^{FB}$. Using (8) and (10) yields the equilibrium price level in the repair market

$$p^* = c + \sqrt{\frac{tf}{\delta}}\,. \tag{11}$$

q.e.d.

Proof of Proposition 1

As w_n is obviously strictly increasing in δ, the third-best solution is characterized by

$$\frac{\partial w_l}{\partial \delta} = \pi\left(c + \sqrt{\frac{tf}{\delta}}\right) - \left(c + \sqrt{\frac{tf}{\delta}}\right) + \frac{1}{2}\pi(1-\delta)\sqrt{\frac{tf}{\delta^3}} + \frac{1}{2}\delta\sqrt{\frac{tf}{\delta^3}} - \frac{1}{8}\sqrt{\frac{tf}{\delta}} < 0. \tag{12}$$

Rearranging yields

$$(1-\pi)\left(\delta c + \sqrt{\delta tf}\right) + \frac{1}{8}\sqrt{\delta tf} > \frac{1}{2}\left(\delta + \pi(1-\delta)\right)\sqrt{\frac{tf}{\delta}} \tag{13}$$

The LHS of (13) tends to zero and the RHS of (13) tends to infinity for δ converging to zero. Thus, for a given loss probability π, production costs c and transportations costs t, there will always be a critical coinsurance rate $\delta^c > 0$ such that the impact of a marginal increase in coverage in the state of loss is zero. Since consumers' wealth in the no loss state is strictly increasing in δ, the third-best coinsurance rate δ^{TB} has to be greater than δ^c.

q.e.d.

Proof of Proposition 2

A necessary condition for $\delta^{TB} < 1$ is that the marginal expected utility evaluated at $\delta = 1$ is negative.

$$\left.\frac{\partial EU}{\partial \delta}\right|_{\delta=1} = (1-\pi)\pi\, u'(w_n)\big|_{\delta=1}\left(c+\sqrt{tf}\right) + \pi\, u'(w_l)\big|_{\delta=1}\left[\pi\left(c+\sqrt{tf}\right) - \left(c+\sqrt{tf}\right) + \frac{1}{2}\sqrt{tf} - \frac{1}{8}\sqrt{tf}\right] < 0 \tag{14}$$

Rearranging terms yields the condition

$$\left.\frac{u'(w_n)}{u'(w_l)}\right|_{\delta=1} < \frac{(1-\pi)\left(c+\sqrt{tf}\right) - \left(\frac{3}{8}\right)\sqrt{tf}}{(1-\pi)\left(c+\sqrt{tf}\right)}\,. \tag{15}$$

The RHS of (15) is strictly smaller than one. The LHS is strictly between zero and one and decreases in the consumer's absolute risk aversion. Therefore, (15) is only be met if consumers are sufficiently risk-averse.

If consumers are sufficiently risk-averse, δ^{TB} is implicitly defined by

$$\frac{(1-\pi)\left(c+\sqrt{\frac{tf}{\delta^{TB}}}\right) + \frac{1}{8}\sqrt{\frac{tf}{\delta^{TB}}} - \frac{1}{2}\left(\pi(1-\delta^{TB}) + \delta^{TB}\right)\sqrt{\frac{tf}{\left(\delta^{TB}\right)^3}}}{(1-\pi)\left(c+\sqrt{\frac{tf}{\delta^{TB}}}\right) + \frac{1}{2}(1-\pi)(1-\delta^{TB})\sqrt{\frac{tf}{\left(\delta^{TB}\right)^3}}} = \frac{u'(w_n)}{u'(w_l)}\,. \tag{16}$$

Consumers prefer to stay uninsured with $\delta^{TB} = 1$ if

$$\left.\frac{u'(w_n)}{u'(w_l)}\right|_{\delta=1} \geq \frac{(1-\pi)\left(c+\sqrt{tf}\right) - \left(\frac{3}{8}\right)\sqrt{tf}}{(1-\pi)\left(c+\sqrt{tf}\right)}\,. \tag{17}$$

The LHS of (17) increases as the consumer's risk aversion decreases. For a virtually risk-neutral consumer, the LHS converges to one. Therefore, the third-best contract for a weakly risk-averse consumer does not provide any coverage.

q.e.d.

Proof of Proposition 3

We consider an insurance market with $m \geq 1$ identical insurers that compete simultaneously in contracts. For convenience we further assume that insurers who offer the same utility maximizing contract split the market equally. First we look at the effects of a single insurer's variation of the coinsurance rate δ_i on the repair market.

A consumer located between suppliers *j* and one of its neighbors is indifferent between the two competitors if

$\delta_i p_j + tx = \delta_i p + t(1/n - x)$ if the consumer is insured by the insurer *i* and

$\delta_{-i} p_j + tx = \delta_{-i} p + t(1/n - x)$ otherwise.

The fraction of consumers insured by *i* is $\frac{1}{m}$, while the fraction of consumers not insured by *i* is $\frac{m-1}{m}$.

The resulting demand function of firm j is given by

$$D_j(p_j, p) = 2x = \frac{1}{n} + \frac{1}{m}\left(\frac{\delta_i (p - p_j)}{t}\right) + \frac{m-1}{m}\left(\frac{\delta_{-i}(p - p_j)}{t}\right). \qquad (18)$$

For a symmetric equilibrium one obtains

$$p = c + \frac{t}{\left(\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}\right)n}. \tag{19}$$

The zero profit constraint implies

$$n = \sqrt{\frac{t}{\left(\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}\right)f}} \tag{20}$$

and

$$p^* = c + \sqrt{\frac{tf}{\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}}}. \tag{21}$$

Now we are able to determine the optimal contract for insurer *i*. It is given by

$$\max_{\delta_i} \quad EU(\delta_i, \delta_{-i}, m) = (1-\pi)\,u(w_n) + \pi u(w_l) \tag{22}$$

with

$$w_n := w_0 - \pi(1-\delta_i)\left(c + \sqrt{\frac{tf}{\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}}}\right)$$

$$w_l := w_0 - \left(\pi(1-\delta_i) + \delta_i\right)\left(c + \sqrt{\frac{tf}{\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}}}\right) - \frac{1}{4}\sqrt{\left(\frac{1}{m}\delta_i + \frac{m-1}{m}\delta_{-i}\right)tf}.$$

The first order condition for an interior solution is given by

$$\frac{\partial EU(\delta_i,\delta_{-i},m)}{\partial \delta_i} = (1-\pi)\,u'(w_n)\frac{\partial w_n}{\partial \delta_i} + \pi u'(w_l)\frac{\partial w_l}{\partial \delta_i} = 0\,. \tag{23}$$

Subsequently, using the implicit functions theorem we show that the equilibrium coinsurance rate δ_i^* decreases in the number of operating insurance companies, m. We consider:

$$\frac{\partial \delta_i^*}{\partial m} = -\frac{\dfrac{\partial^2 EU}{\partial \delta_i^* \partial m}}{\dfrac{\partial^2 EU}{\partial (\delta_i^*)^2}} = -\frac{\dfrac{\partial}{\partial m}\left((1-\pi)u'(w_n)\dfrac{\partial w_n}{\partial \delta_i^*} + \pi u'(w_l)\dfrac{\partial w_l}{\partial \delta_i^*}\right)}{\dfrac{\partial}{\partial \delta_i^*}\left((1-\pi)u'(w_n)\dfrac{\partial w_n}{\partial \delta_i^*} + \pi u'(w_l)\dfrac{\partial w_l}{\partial \delta_i^*}\right)}\,. \tag{24}$$

Because of the second order condition for a maximum, the denominator in the expression on the RHS of (24) is negative. Thus, it is sufficient to show that the nominator is also negative:

$$\begin{aligned}&\frac{\partial}{\partial m}\left((1-\pi)u'(w_n)\frac{\partial w_l}{\partial \delta_i^*} + \pi u'(w_l)\frac{\partial w_n}{\partial \delta_i^*}\right) = \\ &\underbrace{(1-\pi)u''(w_n)\frac{\partial w_n}{\partial \delta_i^*}\frac{\partial w_n}{\partial m}}_{:=(I)} + \underbrace{(1-\pi)u'(w_n)\frac{\partial^2 w_n}{\partial \delta_i^* \partial m}}_{:=(II)} + \underbrace{\pi(1-\pi)u''(w_l)\frac{\partial w_l}{\partial \delta_i^*}\frac{\partial w_l}{\partial m}}_{:=(III)} + \underbrace{\pi u'(w_l)\frac{\partial^2 w_l}{\partial \delta_i^* \partial m}}_{:=(IV)}\end{aligned} \tag{25}$$

We derive

$$\frac{\partial w_n}{\partial m} = \frac{1}{2}\pi ft(1-\delta_i)\frac{\delta_i - \delta_{-i}}{\sqrt{mft(\delta_i - \delta_{-i} + m\delta_{-i})^3}} \tag{26}$$

and

$$\begin{aligned}\frac{\partial w_l}{\partial m} = -\frac{\delta_{-i}-\delta_i}{8m(\delta_i - \delta_{-i}(1-m))}&\left[\sqrt{\frac{ft}{m}(\delta_i - \delta_{-i}(1-m))} - 4\delta_i\sqrt{\frac{mft}{(\delta_i - \delta_{-i}(1-m))}}\right.\\ &\left.-4(1-\delta_i)\pi\sqrt{\frac{mft}{(\delta_i - \delta_{-i}(1-m))}}\right]\end{aligned} \tag{27}$$

At $\delta_i^* = \delta_{-i}^*$ these partial derivatives and, therefore, expressions (I) and (III) are zero. Additionally, since

$$\left.\frac{\partial^2 w_n}{\partial \delta_i^* \partial m}\right|_{\delta_i^* = \delta_{-i}^*} = -\frac{1}{2}\frac{\pi\left(1-\delta_i^*\right)}{m^2}\sqrt{\frac{tf}{\left(\delta_i^*\right)^3}} < 0 \tag{28}$$

and

$$\frac{\partial^2 w_l}{\partial \delta_i^* \partial m} = -\frac{1}{8m^2\delta_i^*}\left(3\sqrt{ft\delta_i^*} + 4\pi\sqrt{\frac{tf}{\delta_i^*}} - 4\pi\sqrt{ft\delta_i^*}\right) < 0\,, \tag{29}$$

(II) and (IV) are negative which proves the proposition.

q.e.d.

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