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Imperfect Tests and Natural Insurance Monopolies

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Abstract

In a housing insurance market buildings have different damage probabilities. High-risk houses need investment, low-risk houses don't. Insurers use imperfect tests to assess risks. The market is a natural monopoly: with more than one active insurer, high-risk house owners continue to apply to insurers until they are eventually assigned to the low-risk class. The natural monopoly need not be sustainable. In equilibrium the incumbent accommodates entry even when the natural monopoly is sustainable. We explain recent observations from Germany and Switzerland where damage rates and prices went up drastically after the transition from state monopolies to competitive environments.
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1. Introduction

The benefits of liberalizing housing insurance markets have been questioned by recent evidence from Switzerland and Germany. In Switzerland housing insurance is mandatory. In seven cantons the housing insurance market is competitive, while in the other 19 cantons the compulsory insurance is provided by state monopolies. If Switzerland is going to accept the 3rd EU guideline on insurance, which is currently being debated, this could mean the end of the state monopolies. Von Ungern-Sternberg ((1994),(1995),(1996)) compared the terms of insurance in the cantons having a state monopoly with the terms in the cantons where there is competition. He found that, for very similar products, the state monopolies charge prices being 40% lower than those of private insurers, that they spend substantially more on fire prevention, and that they have substantially lower damage rates—all this without making losses. He concluded that the abolishment of the state insurance monopolies is a bad idea if economic efficiency is the ultimate aim.[1]

Similar findings have been obtained for Germany. There 13 regional monopolies had prevailed including the two big southern states of Baden-Württemberg and Bavaria; in the rest of the country housing insurance markets were competitive. The 3rd EU guideline, which was adopted in 1992 and took effect on July 1 1994, led to the abolishment of the state monopolies in the housing insurance market. As a result there has been entry in these markets and premium rates have increased by more than 50% since 1992 in the state of Baden-Württemberg (Epple and Schäfer (1996)). Felder (1996) reports for 1993 a difference of 30% between the premia of state monopoly insurers and private insurers (averages of more than 50 insurers for standard one- or two family houses). Since then the rates of the former monopolies have gone up, leading to a convergence of premium rates.[2] The monopolists'

[1] The monopoly insurers hired Prof. von Ungern-Sternberg from the University of Lausanne as an industrial organizations expert. The private insurers who want to enter the monopolized housing insurance markets weren't happy about his findings and they hired Prof. Schips from the ETH Zürich to have another look at the market. He argues (Schips 1995) that not the state monopolies but the private insurers are cheaper. The issue was finally settled with a paper by Kirchgässner (1996) who argues rather convincingly that there is really something to von Ungern-Sternberg's stylized facts. See Appendix B for more details on this dispute.

[2] In Baden-Württemberg the two former state monopoly insurers were transformed into

markups on damage rates over the period 1980 - 1994 were about half the markup of competitive firms, and damage rates of the state monopolies were lower.

There is thus some evidence that in the housing insurance market state monopolies outperform private insurers in a competitive environment. Since the premia of the former state monopolies have gone up to the levels of the private insurers after the markets have been opened up for competition, the reason for this better performance seems not to be that the monopolies are run by the state and the competitors are private. Apparently, then, the housing insurance market is better served by a monopolist, be it private or state, than by several insurers competing against each other.

Von Ungern-Sternberg (1996) explains the price differentials by selling costs incurred in a competitive industry. He finds that the costs of acquisition make up between 15% to 20% of the annual premium payment. Felder (1996) obtains similar results using German data. Kirchgässner (1996) explains the higher damage rates of private insurers by the fact that in case of a damage a private insurer has to be very lenient in awarding compensation in order not to lose disappointed customers to a competitor.[3]

Von Ungern-Sternberg's marketing cost explanation does not fully explain the price and damage differentials between monopoly and competitive insurers. Selling costs of up to 20% cannot fully account for price differences of 40%. To be more precise, even if we subtract marketing costs from total administrative costs, in Switzerland the residual administrative costs of the state monopolies are .1 Swiss Franc (fr) per 1000 fr insurance value lower than the corresponding figure of the private insurers. More importantly, the marketing cost explanation cannot fully explain the difference in the damage rates (von Ungern-Sternberg, private correspondence). Moreover, if consumers care mostly about "getting the lowest price", then selling costs should not have much bite anyway.[4]

public limited companies and then merged under the aegis of the savings banks financial group (Epple and Schäfer (1996)).

[3] Oliver Hart suggested that just the opposite is the case: the first thing insurers often do in case of an accident is to try to get rid of the customer.

[4] Suppose that consumers are not interested in visits by sales representatives, glossy brochures etc. All consumers want to have is the mandatory insurance at a low price. Then the state monopolies should not fear entry after the opening of the market. By

In this paper we provide another explanation for these empirical observations. We set up a model where we try to capture some of the institutional peculiarities of the regulated housing insurance markets under consideration. In the model, buildings are either of high or low damage probability. Neither owners nor insurers know a building's damage type. Insurers use imperfect tests to find out about the damage probability. Imperfect means that a low-risk house may be assigned to the high-risk class and vice versa. If a house is assigned to the high-risk class, the owner should invest to turn it into a low-risk building. To focus on the implications of the imperfect assignments, we assume test costs to be zero.

Insurers offer the mandatory insurance at a uniform price. Insurance is only available if a building is assigned to the low-risk class or the owner has made the investment. Insurers do not explicitly condition their premia on their competitors' test results, although they will infer these results and rationally adjust their premia. If the market is a monopoly, the outcome is simple. All the houses are tested by the monopolist. Those passing the test get the insurance without further hassle; those failing the test must be upgraded to get the mandatory insurance.

The picture changes, however, when several insurers are active. Now those house owners who fail the test in the first round try their luck with a second company. If they fail the test once again, they don't lose anything. Yet they can be lucky and pass this time, thus saving on the investment cost.[5] We first show that this imperfect test scenario may create a natural monopoly, i.e., a situation where it is optimal to submit houses to a single test. If the investment cost is not too high, the harm a second test does

saving on marketing expenses they have lower costs than the private competitors which they can pass on to consumers in the form of lower prices. There are after all a lot of markets where discounters offering no-frills products are doing a good job. Think, e.g., of the US-airline market where cut-price carriers do not even show up in the major reservation systems, yet have ample of customers. Even in the insurance business having lower prices than the competition can be sufficient to attract customers. In Germany there exists a successful insurance company exclusively for civil servants. This insurer is typically cheaper than its competitors. One likely reason for this is that the company tends not to work with sales representatives; another reason could be that the insurer is not very generous in awarding compensation.

[5] Cynics claim that this effect is not only at work in insurance and, say, credit markets, but also in the peer-reviewing process of economic journals.

in getting previously correctly assigned high-risk houses wrong exceeds the benefits of correcting a few of the first round's misjudged low-risk houses.

The next question we ask is whether the natural insurance monopoly is sustainable in the sense of Baumol, Panzar, and Willig (1982). Since the incumbent monopolist has the lowest possible damages, shouldn't he be able to charge a price that, on the one hand doesn't mean losses for him and that, on the other hand is low enough to prevent profitable entry? We consider the concept of sustainability in the present context appropriate because the state monopoly insurers claim not to be profit maximizers.[6] If the natural monopoly is sustainable, they can keep entrants out of the business without making losses and, at the same time, they can still try to follow their welfare goals, whatever these may be.

It turns out that if the investment cost is below a threshold value, the natural monopoly is indeed sustainable while if the cost is above this critical value, this is no longer the case. Thus, when the monopoly is not sustainable, our model explains the stylized facts that as long as the monopoly is protected, damages are low and investments in fire prevention etc. are high. When the market is opened to competition, there is inefficient entry and all the damage rates go up because house owners invest too little in their buildings. Notice that we do not make any statements about prices and profits in this section.

The concept of sustainability has been criticized on several grounds. Moreover, it gives us too little structure to say something about prices. Therefore, we derive next the equilibrium industry structure for a Stackelberg-type game in which first the incumbent and then the entrant chooses his/her price. Here we assume that both insurers seek to maximize profits.

We find that when the monopoly is not sustainable, the incumbent will always accommodate entry. He does so by charging the maximum possible price which the entrant, in turn, slightly undercuts. If the monopoly is sustainable, in equilibrium two things may happen. Either the incumbent

[6] The monopoly insurers are independent public corporations. Their aim is to offer insurance for the entire canton at reasonable rates. They are not directly subsidized by the cantons. Indeed, they tend to be profitable. Profits are used to accumulate reserves or they are distributed to customers. Nevertheless, the monopolies do not pay taxes. However, this indirect subsidy is by no means sufficient to explain the observed price differentials.

accommodates entry in the way just described, or he keeps the entrant out by charging a limit price.[7] Accordingly, for the case of accommodated entry our model explains the empirical observation that after entry the incumbent charges the same high price as the entrant. In summary we may, therefore, conclude that for the appropriate range of investment costs our model explains the stylized facts of the Swiss and German housing insurance markets pretty well.

Our paper is related to the literature on the economics of testing in environments of asymmetric information. Guasch and Weiss (1980, 1981) and Nalebuff and Scharfstein (1987), for example, consider labor markets with asymmetric information. Workers know their productivities while firms do not. In equilibrium high productivity workers choose to be tested and get a high wage if they pass while low productivity workers prefer no test and a low wage. In these models tests are, essentially, screening devices to overcome the asymmetries of information. In contrast, our model is characterized by symmetric information and the purpose of the test is to reduce the uncertainty.

Broecker (1990) considers banks using credit-worthiness tests in an asymmetric information set-up. Like us he has the effect that the more banks are active, the more applicants pass the credit-worthiness test of at least one bank. However, he does not allow for active measures to reduce the default probability. Theses measures are crucial to our story. He is mainly interested in characterizing the mixed strategy equilibrium when many banks are active. Our main focus is on the natural monopoly property created by imperfect tests and the extend to which this natural monopoly can be sustained.

The remainder of the paper is organized as follows. In the next section we describe the basic model. In section 3 we derive the natural monopoly condition. In the subsequent section we analyze the sustainability of the natural monopoly. In section 5 we derive the industry equilibrium. Section 6 concludes.

[7] Throughout the paper we use the term limit price for a price low enough to keep the entrant out of the market.

2. The Model

We consider a housing insurance market with a continuum of houses having total mass 1. Each house is subject to one (and just one) damage caused by fire, storm, or flooding say. The level of damages is the same for each house and normalized to 1. The risks of experiencing a damage are independent.[8]

Houses are of type $t = h, l$ where $1 > h > l > 0$ are the probabilities of suffering from the damage. These different damage probabilities may be due to how well the house was built, the condition of the soil, etc. Given our normalization of the level of damage, h and l at the same time denote the expected damages per house. A houseowner does not know which type of house he owns. Thereby, we rule out any possibility of signaling and screening in the housing insurance market. Let $\lambda \in (0, 1)$ be the fraction of h-houses and $(1 - \lambda)$ the fraction of l-buildings. The average expected damage probability (the average expected damage) in the insurance market is $\bar{c} = \lambda h + (1 - \lambda)l$.

The housing insurance market is subject to regulation. With our assumptions we try to capture the institutional facts of the Swiss and German housing insurance markets. Each houseowner is required to purchase complete insurance for his house, meaning an insurance coverage of 1 is compulsory for each building. Since complete insurance is mandatory, we need not further bother about the consumers' risk preferences. All we need to assume is, quite realistically, that consumers try to get the mandatory housing insurance as cheap as possible. Moreover, in order not to work on open sets, let there be a maximum price $p_{\max}$ that firms can charge for the mandatory insurance. Demand is thus completely inelastic up to the maximum price $p_{\max}$. To have surplus in the market, let $p_{\max} > h$.[9]

House insurers cannot perfectly monitor the type of a house. Each insurer possesses, however, an imperfect test to determine the damage probability

[8] Any independence assumption in the paper can be relaxed to 'not perfectly correlated random variables'.

[9] Suppose that for prices exceeding $p_{\max}$ consumers run the risk of violating the law by not getting insurance. Note that the undergraduate textbook monopolist would charge exactly $p_{\max}$. In Germany and Switzerland the state monopolies charge lower prices than insurers operating in a competitive environment, meaning that the monopolies do not charge the maximum price. This seems to indicate that profit maximization is indeed not their ultimate target.

of a house. As an example think of the test simply as the insurer's expert assessing the risk of the building.[10] Such a test randomly assigns the house to one of the two categories H and L. Let $q(T|t)$ be the probability that a house is assigned to $T = H, L$ conditional on being $t = h, l$. The probabilities of the four possible outcomes are thus

$$q_h := q(H|h), \qquad 1 - q_h = q(L|h),$$

$$q_l := q(H|l), \quad \text{and} \quad 1 - q_l = q(L|l).$$

Let $q_l < q_h$ which implies that more l- than h-houses are assigned to L. The parameters q_l and q_h are the same for all insurers. If an insurer applies his test repeatedly, the outcomes are perfectly correlated meaning that a building's first assignment doesn't change in further rounds. An insurer thus doesn't gain additional information by applying his test more than once.[11] In contrast, the tests of different insurers are stochastically independent for any given house meaning that the assignment of one insurer doesn't affect the chances with another company. To focus exclusively on the role of the

[10] Such tests are commonly used, in particular when large values are at stake, such as in industrial fire insurance. In the monopoly cantons a direct subsidiary of the monopoly insurers (the Feuerpolizei) is in charge of the monitoring. Private insurers also try to assess the damage probabilities of buildings. According to Schips (1995), one of the advantages of the private over the monopoly insurers is that their premia better reflect the underlying risks. They grant, e.g., discounts if the owner makes additional investments in safety. According to the Feuerpolizei of the canton Bern, our approach is best suited for large risks, where there is indeed individual damage assessment by different companies. For small risks the situation is somewhat different. In the monopoly cantons the insurer strictly enforces the regulations. In the competitive cantons private insurers seem to have less incentive to do so. Here two stories can support the lax standards. Either houseowners keep on calling up insurers until they find somebody offering insurance without inspecting the house, an outcome similar in spirit to our approach. Or, if enforcement is a public good, a monopolist enforces regulations because he appropriates the entire benefits thereof. In a competitive environment no insurer enforces regulations; everybody tries to free-ride on the others (see Arnott and Stiglitz (1986)).

[11] Insurers tend to use their own in house experts, typically one expert for a particular region. It seems reasonable to assume that the same expert reaches the same conclusion when he has a second look at a building. We discuss reasons why insurers use their own tests in Section 3.

miscategorizations, test costs are assumed to be zero. We will comment on positive test costs in the Conclusions.

To further explain the test, suppose just one insurer is active. Call him the 'incumbent'. All house owners go to the incumbent who applies this test. By the law of large numbers he assigns λq_h h-houses to H, $\lambda(1-q_h)$ h-houses to L, $(1-\lambda)q_l$ l-houses to H, and $(1-\lambda)(1-q_l)$ l-houses to L. Accordingly, the proportion of h-houses in the set of houses assigned to H is $c(h|H) = \lambda q_h/[\lambda q_h + (1-\lambda)q_l]$ and the proportion of l-houses in the H-set is $c(l|H) = 1 - c(h, H)$. Analogously, the proportion of l-houses in the set of houses assigned to L is $c(l|L) = (1-\lambda)(1-q_l)/[(1-\lambda)(1-q_l) + \lambda(1-q_h)]$ and the proportion of h-houses in the L-set is $c(h|L) = 1 - c(l|L)$.

The average damage in class H is, therefore, $c_H = c(h|H)h + c(l|H)l < h$ and in the L class $c_L = c(h|L)h + c(l|L)l > l$. The assumption $q_l < q_h$ then implies $c_L < \bar{c} < c_H$, which means that the houses assigned to L have lower expected damage than the houses assigned to H and, more importantly, than the average in the economy.

If a house has been assigned to class H, something suspicious has been found. The house owner can then invest in his building to decrease the probability of experiencing a damage. More specifically, if the owner invests $x > 0$, his house is certainly an l-one. If his house is of type l anyway, investing x does not hurt, i.e., the investment neither lowers nor increases the expected damage. In this case the investment is simply a waste of money that, however, is not harmful. Yet, if the house is of type h, the investment lowers the expected damage by $(h-l)$ so that the investment of x turns a h-house into a l-house.[12] It is efficient to invest in h-houses, i.e., $x < (h-l)$.[13]

[12] Note that our qualitative results do not change if the investment were 'less productive' in the sense that after the investment of x only the test assigns the building to L instead of being of type l for sure. More importantly, note that if the house has been assigned to L or has not been tested at all, nothing suspicious has turned up and the owner cannot invest. We thus assume that blind investment is not possible. At the end of section 4 we will explain how our results change with blind investment.

[13] We assume in the theoretical model that investments are efficient taking into account investment costs and expected losses. We lack the data to test whether this assumption is satisfied in reality. Critics claim that the monopoly insurers may be too tough on regulations. As one referee points out, a monopolist who cannot extract additional surplus in the insurance market due to price regulation, does so by inducing excessive investment. The only evidence we have in support of our assumption is that the monopoly insurers

Since house owners do not know their building's type, the only available means to find out about the damage probability is applying the test. Let us stick to the situation with just one insurer, the incumbent. Suppose the incumbent adheres to the following simple policy: The houses assigned to H are required to invest x to get the insurance while those assigned to L get the insurance without investment.[14] With this policy $\lambda(1-q_h)$ h-owners do not invest, λq_h h-owners efficiently invest, $(1-\lambda)q_l$ l-owners unnecessarily invest, and $(1-\lambda)(1-q_l)$ l-owners correctly do not invest.

We assume that despite these judgement errors, the total cost of this policy TC_1 is lower than the cost of not testing and investing at all. Formally,

$$TC_1 = \lambda(1-q_h)h + \lambda q_h(l+x) + (1-\lambda)(1-q_l)l + (1-\lambda)q_l(l+x) < \bar{c},$$

$$\text{or} \qquad f := \frac{\lambda q_h(h-l)}{(1-\lambda)q_l + \lambda q_h} > x,$$

meaning that the net benefit of the investments in the h-buildings exceeds the costs of the erroneous investments in the l-buildings. If the incumbent follows this policy, he incurs expected damages/costs

$$c_1 := [1-\lambda(1-q_h)]l + \lambda(1-q_h)h = l + (h-l)\lambda(1-q_h). \qquad (1)$$

Note that $c_1 < c_L$. Compared to the scenario where only buildings assigned to L are in the pool, the monopolist adds all the H-buildings which are of type l after the investment, thus lowering expected costs.

3. Competition

Let us now analyze the consequences of introducing competition in the housing insurance market. To keep matters simple we consider the situation where just one insurer contemplates entering the housing insurance market.[15] Call this insurer the 'entrant'.

voluntarily spend double the amount on fire prevention than do private insurers (13.2 versus 6 centimes per 1000 francs insurance value).

[14] The assumption that blind investments are not possible rules out the possibility of the insurer always claiming that the building failed the test thus requiring the investment from all owners.

[15] For an analysis of competition in the presence of the externality created by imperfect tests with more than two players, see Broecker (1990).

The entrant uses a test as described in the previous section, i.e., the entrant's test parameters are also q_h and q_l. Furthermore, the incumbent's and the entrant's tests are stochastically independent for any given house. The insurers' experts use two different mechanisms to find out about a building's risk class developed by, say, two different technical universities. The two mechanisms use different procedures to generate the information, but no mechanism is better than the other.

Due to regulation insurers have to offer the mandatory insurance conditional on being assigned to L or having invested x. Moreover, insurers have to charge a uniform price for the mandatory insurance, i.e., they may not discriminate between those houses assigned to L and those buildings being upgraded.[16]

The two companies do not condition their contract terms on their competitor's test outcome.[17] Regulation often rules out conditioning the own contract terms directly on the competitors' tests because this might lead to collusion. Insurers themselves may be reluctant to have their rates depend on the competitors' tests because this may lead to additional uncertainty or even strategic manipulations.[18] Such direct conditioning is simply impossible if the test results are observable but not verifiable. Finally, if consumers simultaneously apply to all insurers and then pick the best offer, at the time of the application no test results are available; asking consumers for other test results is useless in such a situation.[19]

[16] Recall that the policy of upgrading high-risk houses is efficient under our assumptions. To put it differently, in our set-up insurers do not want to offer high rates to high risks; low rates with investment is cheaper. The assumption that insurers do not discriminate between L houses and upgraded houses is made for simplicity. All of our qualitative results hold if an upgraded house has the same characteristics as an L house, though the algebra is messier.

[17] This is the standard assumption made in the literature; see Broecker (1990), Guasch and Weiss (1980, 1981), and Nalebuff and Scharfstein (1987).

[18] An insurer has a good grip on his own test but he cannot directly control the quality of the competitors' tests (as Benjamin Franklin put it: "If you want something done right, do it yourself"). An insurer may give all applicants he does not take good test scores so that they get better rates elsewhere, thus lowering the competitors' profitability. Or if tests are costly, an insurer may try to free-ride on the others' tests.

[19] Throughout the paper we tell the story in which owners sequentially apply to the insurers. The formal apparatus, however, is entirely consistent with the set-up in which each owner simultaneously applies to both companies and then picks the better of the two

Nevertheless, note that from the observation of prices an insurer may infer the competitor's test result. If both companies charge different prices, the expensive insurer knows that all of her applicants failed the test of the cheap competitor. In our model insurers rationally use this information, i.e., there is Bayesian updating. If, however, both companies charge the same price, an insurer cannot tell whether an applicant failed the competitor's test.

Suppose the entrant comes in. Denote the price charged by the incumbent by p_I and the entrant's price by p_E. Let $0 < |p_I - p_E| < x$, i.e., one insurer is cheaper than the other but the price differential is lower than the investment cost. In this scenario owners prefer to be insured by the expensive company without investment rather than obtaining the mandatory insurance from the cheap firm under the condition of investing x.

This implies that all house owners first apply to the cheaper company. Those who are assigned to H and thus have to invest x to get insurance from the cheap company give it a shot with the expensive insurer. To be more specific: Those $\lambda(1-q_h)+(1-\lambda)(1-q_l)$ lucky enough to be assigned to L by the cut-rate insurer stay there and get cheap insurance without investment.

The remaining $\lambda q_h + (1-\lambda)q_l$ go to the high-price insurer where their houses are tested a second time. The expensive insurer assigns $\lambda q_h^2 + (1-\lambda)q_l^2$ to H and $\lambda q_h(1-q_h) + (1-\lambda)q_l(1-q_l)$ to L. Those assigned to L purchase insurance from the expensive insurer without investment; those assigned to H finally end up investing x to get the mandatory housing insurance.[20]

The total cost of this policy of testing twice is

$$\begin{aligned} TC_2 &= \lambda(1-q_h)h + (1-\lambda)(1-q_l)l + \lambda q_h^2(l+x) + \lambda q_h(1-q_h)h + \\ &\quad (1-\lambda)q_l^2(l+x) + (1-\lambda)q_l(1-q_l)l. \end{aligned}$$

It is more efficient to test once rather than twice if $TC_1 < TC_2$ or

$$F := \frac{\lambda q_h(1-q_h)(h-l)}{(1-\lambda)q_l(1-q_l) + \lambda q_h(1-q_h)} > x.$$

This condition on investment costs means that the loss of incorrectly assigning $\lambda q_h(1-q_h)$ h-houses to L exceeds the benefit of correcting the wrong

offers.

[20] Of course they will purchase the insurance from the cut-price company. Yet these considerations do not play a role in the following efficiency considerations.

assignment of the $(1-\lambda)q_l(1-q_l)$ l-houses by the cheap insurer. The harm of a second test in getting a couple of the previously correctly assigned houses wrong exceeds the good of correcting a few of the first round's misjudgments. The reason why the second test does worse than the first test even though it has the same characteristics is that in the second round the sample of houses tested is worse than in the first round.[21]

Note that $F < f$, i.e., if $x < F$, it is not only better to test once instead of twice; $x < F$ also implies that one test is better than no test at all. Moreover, as is easily checked, $x < F$ also implies that it is inefficient to test more than twice. We will, therefore, call the housing insurance market a *natural monopoly* if $x < F$.[22] From now on we will confine our attention to the case where the housing insurance market is a natural monopoly, i.e., $x < F$.

4. Sustainability

The first question we want to ask is whether our natural insurance monopoly is *sustainable* in the sense of Baumol, Panzar, and Willig (1982, 192-193). By sustainability we mean that without any restrictions on entry the incumbent can keep the entrant out of the market. To put it differently: If $x < F$, the market is a natural monopoly, i.e., average damages are at the lowest possible level c_1. Accordingly, the following question arises quite naturally: Shouldn't the monopolist be able to charge a price that, on the one hand doesn't mean losses for him and that, on the other hand is low enough to prevent profitable entry? More precisely, we have the following

[21] This phenomenon is also at the core of the famous *lemons problem*, where the average quality of the used cars that are actually traded is lower than average quality of all cars of the vintage; see Akerlof (1970).

[22] This natural monopoly property depends crucially on the assumption that the insurers do not condition their contract terms on their competitors' test results. By applying a sufficient number of the different tests and conditioning the premium on the entire list of test results, insurers could make the probability of misjudgments arbitrarily small. When we call the 'one-test-scenario' efficient, we assume that the social planner is subject to the same restriction of not using more than one test at a time. Notice, however, that with positive test costs one test may be efficient even when the planner can perform as many tests as he wants to. If the cost of a second test exceeds the benefits thereof, the planner would go for one test.

Definition: *The price of a monopolist is sustainable if the market clears at that price, the monopolist makes a non-negative profit, and no entrant can make a profit taking the incumbent's price as given. A monopoly is sustainable if and only if there exists at least one sustainable price.*

It turns out that if the investment cost is below a threshold value, the natural monopoly is indeed sustainable while if x is above the threshold value, this is no longer the case.

Proposition 1: *Let* $G := \lambda(1-q_h)(h-l)[q_h/(\lambda q_h(1-q_h)+(1-\lambda)q_l(1-q_l))-1]$.
i) If $G < x < F$*, the natural monopoly is not sustainable;*
ii) if $0 < x \leq G$*, the natural monopoly is sustainable.*

Proof: If the incumbent is the sole insurer, he has average damage $c_1 = l + (h-l)\lambda(l-q_h)$. In order not to make losses $p_I \geq c_1$, i.e., c_1 is the lower bound for the price the monopolist can charge. Now suppose the entrant comes in with a price $p_E \in (p_I, p_I + x)$. Then, as we have already explained, all consumers apply to the cheap incumbent and those assigned to L buy there. Those assigned by the incumbent to H try to get insurance from the entrant because $p_E < p_I + x$. If the entrant assigns them to L, they buy insurance from the entrant at the price p_E. If the entrant assigns them H, they return to the incumbent where they end up paying $p_I + x < p_E + x$. In this scenario with two insurers the (expensive) entrant has average damage

$$c_2^e := \frac{\lambda q_h(1-q_h)h + (1-\lambda)q_l(1-q_l)l}{\lambda q_h(1-q_h) + (1-\lambda)q_l(1-q_l)}, \tag{2}$$

meaning that with a price $p_E > c_2^e$ the entrant makes a profit. If $x > G$, $c_1 + x > c_2^e$. Even if the monopolist charges the lowest possible price $p_I = c_1$, the entrant can still profitably enter with a price $p_E \in (c_2^e, c_1+x)$. She attracts customers because $p_E < p_I + x$ and makes profits because the price exceeds her damages.

The incumbent loses customers to the entrant. These customers had to invest under the efficient policy and were low-risks for the incumbent. The incumbent, therefore, has the same amount of h-buildings but fewer l-houses meaning that the (cheap) incumbent's average damages go up to

$$c_2^c := \frac{\lambda(1-q_h)h + [(1-\lambda)(1-q_l) + \lambda q_h^2 + (1-\lambda)q_l^2]l}{\lambda(1-q_h) + [(1-\lambda)(1-q_l) + \lambda q_h^2 + (1-\lambda)q_l^2]} > c_1, \tag{3}$$

which proves *i)*.

In contrast, if $x \leq G$, by charging a limit price $p_I \in [c_1, \min\{c_1+x, c_2^c, c_2^e - x\}]$ the incumbent keeps the entrant out. If the entrant slightly undercuts the limit price p_I, she makes a loss because $p_E < c_2^c$. If she charges the same price $p_E = p_I$, we have a tie in which both insurers get half of the market. In this case half of the owners apply to the incumbent and the other half to the entrant. Those assigned by either insurer to H try the other company where they finally buy their mandatory insurance. Each company has average damage

$$c_2^t := \lambda(1 - q_h^2)h + (1 - \lambda + \lambda q_h^2)l. \tag{4}$$

Note that $c_2^c < c_2^t < c_2^e$. In case of a tie the entrant also makes losses because $p_E < c_2^t$. If the entrant charges $p_E \in (p_I, p_I + x)$, she makes losses because $p_E < c_2^e$. If she charges $p_E \geq p_I + x$, she has no customers and doesn't make positive profits. If she undercuts by more than x, she has the whole market but makes losses because $p_E < c_1$. Accordingly, limit prices $p_I \in [c_1, \min\{c_1, c_2^c, c_2^e - x\}]$ are indeed sustainable. This proves *ii)*.

Q.E.D.

The investment cost thus plays a crucial role in determining whether the natural monopoly is sustainable or not. To see this suppose the incumbent charges the lowest possible price $p_I = c_1$, c_1 as defined by (1). For those house owners whom the cheap incumbent assigns to H, the effective cost of getting insurance there is $c_1 + x$. They try the entrant if $p_E < c_1 + x$. If the entrant attracts these customers, she has average damages c_2^e as defined by (2). If $c_2^e \geq c_1 + x$ ($\Leftrightarrow x \leq G$), the entrant cannot profitably enter the market. If she charges a price that attracts customers, she makes losses. A price not leading to losses doesn't attract customers because investment costs are so low that even accounted for x the incumbent offers the better deal. In contrast, if $c_2^e < c_1 + x$ ($\Leftrightarrow x > G$), the entrant can profitably come in and the natural monopoly is not sustainable.

The critical values F and G depend on certain parameters of the model and allow for the following simple comparative statics exercises.

Corollary: *The natural monopoly is the less likely to be sustainable,*
i) the higher is the fraction of h-houses λ,

ii) the larger is the difference in the damage probabilities $(h-l)$, *and*
iii) the lower is q_h.

<u>Proof:</u> Recall that the natural monopoly is not sustainable if $G < x < F$. Straightforward computations confirm that $F - G = \lambda(1-q_h)(h-l)$. The corollary follows immediately.

Q.E.D.

Increases in λ, $(h-l)$, and $(1-q_h)$, essentially, raise F, i.e., they make it more likely that we have a natural monopoly. These effects on F dominate the effects on G, meaning that the length of the interval (G, F) where the natural monopoly is not sustainable increases. It is of some interest to note that increasing the accuracy of correctly assigning h-houses to H, q_h, increases the probability of having a sustainable natural monopoly. The problem of unsustainability, however, only disappears when $q_h = 1$.

We have thus seen in this section that if the investment cost is above a threshold value we have an unsustainable natural monopoly. If entry is restricted, only one firm is active whose damages are low because consumers invest efficiently in their buildings. If the restrictions on entry are lifted, there is inefficient entry, consumers invest too little in their buildings, and both insurers' damage rates are high. Accordingly our model provides an explanation for von Ungern-Sternberg's (1996) observations that in monopolistic markets damage rates are substantially lower and investments in fire prevention etc. substantially higher than in competitive markets.[23]

To conclude this section let us briefly discuss the situation where we allow for blind investment, meaning that owners can invest even if the house was assigned to L or if it hasn't been tested at all. Obviously, for very low values of x there should be blind investment in all buildings. Blind

[23] To convince the reader that we have not derived knife edge results, consider the following parameter values: $l = .0003$, $h = .0009$, $\lambda = .5$, $q_h = 1 - q_l = .9$. Then we obtain $c_1 = .00033$, $c_2^e = \overline{c} = .0006$, $F = .0003$, and $G = .00027$. c_1 and c_2^e are roughly the average damage rates in the monopoly resp. competitive cantons; see Appendix B. If the investment cost is below the expected damage of a low risk house, we have a natural monopoly (since all numbers are on a yearly basis, x has to be multiplied by the investment's lifetime to get an estimate of the actual amount). If investment costs fall in the top decile of this range, the natural monopoly is not sustainable. The Corollary tells us how these results change with the parameter values. Note that we have deliberately chosen straightforward symmetric parameter values, which, however, are in the sensible range.

investment is more expensive than testing once if $TC_1 \leq l + x \Leftrightarrow B := \lambda(1 - q_h)(h - l)/(1 - (1 - \lambda)) \leq x$. Since $B < F$, we have for $x \in (B; F)$ that one test with mandatory investment for those who are assigned to H is optimal. Interestingly, now the incumbent can never follow this policy and prevent entry. Yet, in this setup entry need not be inefficient. To see this suppose the incumbent charges $p_I = c_1$. Those assigned to H thus end up paying $c_1 + x$ with the incumbent. If the entrant requires blind investment, she has average damage l. By charging a price $p_E \in (l, c_1)$ the entrant attracts all of the incumbent's H-houses and makes positive profits. The incumbent's average damage goes up to $c_L > c_1$. This scenario mimics the policy of one test with mandatory investment, the total cost being TC_1.

5. Equilibrium

By focusing on the concept of sustainability we have analyzed whether or not the incumbent can keep the entrant out of the market without making losses. Nevertheless, these results do not answer the question whether the incumbent actually wants to keep the entrant out. Perhaps the incumbent is better off by accommodating entry. It seems perfectly conceivable that charging a sustainable price means lower profits for the incumbent than letting the entrant in and being in a duopoly situation.[24]

To answer this question we need some more structure on the strategic interaction between the two firms. Several possible modeling strategies may come to mind. For the purpose of technical tractability we consider the following Stackelberg-type two stage game.[25] In the first stage the incumbent sets his price p_I. In the second stage, upon having observed p_I, the entrant picks her price p_E. To avoid technical openness problems, we discretize the price space to $\mathcal{P} := \{0, \varepsilon, 2\varepsilon, ..., p_{\max}\}$, ε sufficiently small. Accordingly, ε is the smallest unit of account; if, say, the entrant wants to slightly undercut the incumbent, she does so by ε. For notational convenience also assume c_2^e given by (2), c_2^c defined by (3), and x are in $\mathcal{P}$.[26] Risk neutral insurers

[24]See, e.g., Hay and Morris (1991, 576-580) or Tirole (1988, 308-311) for critical discussions of the concept of sustainability.

[25]We choose the leader-follower rather than simultaneous pricing game to avoid mixed strategy equilibria.

[26]To be formally correct define C_2^e and C_2^c as the smallest numbers in $\mathcal{P}$ greater or equal to c_2^e and c_2^c work with C_2^e and C_2^c instead of c_2^e and c_2^c.

seek to maximize expected profits. We focus on subgame perfect equilibria. The following selection rule guarantees uniqueness of the equilibrium: If an insurer is indifferent between two prices, he/she goes for the higher one.

We now have to deal in more detail with the possibility that the entrant puts the incumbent out of business by undercutting with $(x+\varepsilon)$. Given the incumbent's price, the entrant compares undercutting by ε and getting a fraction of the market with damages c_c^2 with undercutting by $(x+\varepsilon)$ and getting the whole market with damages c_1. The entrant prefers undercutting by ε rather than undercutting by $(x+\varepsilon)$ if $(p_I - c_2^c)(\lambda(1-q_h)+(1-\lambda)(1-q_l)+\lambda q_h^2+(1-\lambda)q_l^2) \geq p_I - x - c_1 \Leftrightarrow p_I := \overline{p} \leq (x+c_1-c_2^c)/(\lambda q_h(1-q_h)+(1-\lambda)q_l(1-q_l)) + c_2^c$. Obviously, the incumbent will always choose prices below $\overline{p}$ because he is then in the market and makes positive profits whereas profits are zero when out of business. Depending on the parameter values, the entrant's best answer to $p_I = \overline{p}$ is to either undercut slightly or to go for the residual demand. This actually gives rise to several tedious subcases. If we restrict our attention to the case $p_{\max} \leq \overline{p}$, the entrant's best answer to the highest price the incumbent may charge $p_I = p_{\max}$ is to slightly undercut. Note that this assumption implies in particular $x > c_2^c - c_1$.

Given this simplifying assumption, the equilibrium has a rather straightforward structure. Either the incumbent charges a limit price that keeps the entrant out of the market (formally, the entrant charges $p_{\max}$ and has no customers given the incumbent's price); or the incumbent accommodates entry. In this case the incumbent charges $p_{\max}$ which the entrant, in turn, slightly undercuts. We have thus inefficient entry and the insurers rip off consumers. The incumbent's choice depends on whatever option is more profitable for him.

Proposition 2: *Let* $p_{\max} \leq (x+c_1-c_2^c)/(\lambda q_h(1-q_h)+(1-\lambda)q_l(1-q_l))+c_2^c$. *In the unique subgame perfect equilibrium*

i) if $\min\{c_2^c, c_2^e - x\} - c_1 > (p_{\max} - c_2^e)[\lambda q_h(1-q_h)+(1-\lambda)q_l(1-q_l)]$, $p_I^* = \min\{c_2^c, c_2^e - x\}$ *and* $p_E^* = p_{\max}$;

ii) if $\min\{c_2^c, c_2^e - x\} - c_1 \leq (p_{\max} - c_2^e)[\lambda q_h(1-q_h)+(1-\lambda)q_l(1-q_l)]$, $p_I^* = p_{\max}$ *and* $p_E^* = p_{\max} - \varepsilon$.

The proof is relegated to the Appendix A. The basic argument is as follows. There are two classes of subgames, one with entry and one without. If the incumbent charges the limit price $p_I = \min\{c_2^c, c_2^e - x\}$, the entrant stays out of the business by choosing $p_{\max}$. The incumbent has the entire market and makes the profit $\min\{c_2^c, c_2^e - x\} - c_1$.

More interesting are the cases where there is entry. There we first show that the entrant will never charge the same price as the incumbent. If the entrant slightly undercuts the incumbent, she has lower average damages $c_2^c < c_2^t$, c_2^t given by (4), and a larger clientele.

This means that the entrant either undercuts the incumbent by ε or goes for the residual demand by charging $p_{\max}$. If the incumbent charges a very low price, the entrant will opt for the residual demand; in contrast, if the incumbent quotes a very high price, the entrant will undercut. This implies, that there exists an incumbent's price $\hat{p}_I$ where the entrant is indifferent between the two strategies. For any price $p_I \leq \hat{p}_I$, the entrant opts for the residual demand by charging $p_{\max}$. Obviously, among these subgames $\hat{p}_I$ generates the highest profit for the incumbent. From the definition of $\hat{p}_I$ follows that both insurers make the same profit, the incumbent with the low price and the entrant with the high price.

For any price $p_I > \hat{p}_I$, the entrant will undercut the incumbent by ε. Accordingly, if the incumbent chooses this undercutting scenario, he will obviously do so with $p_{\max}$. Nevertheless, by choosing $p_{\max}$ and being undercut the incumbent makes the same profit as if he picks $\hat{p}_I$ and the entrant is the more expensive insurer.[27] Thus, given our selection rule, the incumbent chooses $p_{\max}$ and makes the profit $(p_{\max} - c_2^e)[\lambda q_h(1 - q_h) + (1 - \lambda)q_l(1 - q_l)]$. Depending on where the incumbent's profits are higher, we observe in equilibrium a limit price or accommodated entry. Note that when entry occurs prices are high. Accordingly, our model is able to cope with Felder's (1996) observation that the monopoly insurer's after entry rates went up to the private insurers' high levels.

It is of some interest to compare the concept of sustainability with the equilibrium industry structure of our game. When the monopoly is not sustainable, the incumbent certainly accommodates entry because charging a limit price means losses if the monopoly is unsustainable. When the monopoly is sustainable, the incumbent either accommodates entry or he charges a limit price that keeps the entrant out. If the profits from charg-

[27]For certain parameter constellations $p_{\max}$ even yields a higher profit than $\hat{p}_I$.

ing a sustainable limit price are positive but low, the incumbent prefers the duopoly. Thus, in our insurance example, sustainability is necessary but not sufficient to prevent inefficient entry.

6. Conclusions

We have presented a model of an insurance market where the use of imperfect tests creates a natural monopoly: in the efficient market structure buildings should be tested only once. The harm of a second test in getting a couple of previously correctly assigned houses wrong exceeds the good of correcting a few of the first round's misjudgments. We show that this natural insurance monopoly need not be sustainable, i.e., it is not possible for the incumbent to charge a non-loss making price that keeps the entrant out. Moreover, we show for a particular market structure that in equilibrium the incumbent may accommodate entry even though the natural monopoly is sustainable. If there is entry, both, the incumbent and the entrant rip off consumers with high prices.

Our model is able to explain three well established stylized facts from the German and Swiss housing insurance markets. There damage rates have been found to be substantially lower for regions with a monopoly than for regions where there is competition. Moreover, investments in fire prevention etc. are considerably higher in the monopolistic markets than in the competitive ones. Finally, after lifting restrictions on entry, the former monopoly insurers charge the same high prices as the private insurers. Note that the stylized facts hold for small as well as for large risks (Felder and Brinkmann1996).[28] Our approach is best suited to explain the empirical observations for large risks. Von Ungern-Sternberg's marketing cost is a sensible explanation for small risks. Accordingly, the two explanations should perhaps be seen as complements rather than substitutes.

Note that the model does not explain the empirical observation that the incumbent's prices went up after the market was opened. In section 4 we do not derive prices. By working with the concept of sustainability we obtain results about damage rates and investment behavior without specifying the

[28] The surchages of private insurers on damage rates are somewhat lower for large risks than for small risks which Felder and Brinkmann take as indication of more competition in the large risks market.

insurers' objective functions; the limited structure of this section, however, doesn't allow us to determine the prices companies charge.

At this point it seems appropriate to discuss the basic assumptions driving our results in more detail. Testing houses to assess their damage probability is common practice, even in countries with different institutions from the ones we consider.[29] It is obvious that all these test-procedures tend to be imperfect. Insurers also often insist on having the building meet certain (minimum) safety standards rather than raising the premium, in particular, if this is inefficient as in our set-up.[30] Moreover, such a fine-tuning of premia leads to substantially higher transactions costs than the use of standardized contracts. Finally, it is common practice that insurance companies send their own experts to assess large risks.[31]

This last feature actually creates our inefficiency. It is the testing part of the business that creates the natural monopoly, not the insurance activity. It is because each insurer has its own proprietary testing that consumers can exploit the imperfection of testing procedures, which, in turn, makes competition inefficient. If the testing procedure is monopolized and insurance companies require that the monopolists's test is passed, than competition in the insurance business is not inefficient. Such a procedure is, e.g., common practice in Germany and the UK for auto insurance. Government agencies check the safety of cars every so often and without having passed cars get no insurance.[32]

Another way to solve our problem is as follows: Before conducting the test, houseowners pay a flat premium which includes housing insurance plus additional investment insurance. Then the test is performed and the insurer

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[29] In California, for example, the seller of a house must provide a 'termite report' describing the general condition of the building. To get a mortgage, banks generally require the buyer to fix anything the report objected to and the buyer must obtain housing insurance. In the UK the mortgage company, which often also supplies housing insurance, sends one of its agents to inspect the house for sale.

[30] Recall that in our model it is cheaper to upgrade and pay low rates rather than to pay high rates.

[31] See, e.g., http://www.bestreview.com/archives/1999-09/pccover.html on how risks of amusement parks are assessed.

[32] Anecdotal evidence suggests, though, that our assumption of perfect correlation of the outcomes by repeatedly applying the same test is not true for these agencies. It is always a good strategy to try another outlet of the agency if the car failed the test.

pays for any investment. If the insurer invests efficiently, he has average cost TC_1. Bertrand-competition among insurers will drive down prices to TC_1 so that with this form of contracting competition implements the efficient outcome. This theoretically appealing proposal in which the insurer bears the investment risk gives, however, rise to a new set of problems: if the insurance company is going to pay for safety investments anyway, why should owners do so in the first place? We would run into a moral hazard problem concerning safety investments. In our institutional setup houseowners bear the investment risk alone and, accordingly, have proper incentives concerning investment. They get, however, full insurance for the risk of flooding etc. Here we have in mind that consumers have little influence on the underlying causes such as, say, earthquakes or El Niño.

We have deliberately assumed the test to be costless: A costly test would only reinforce the natural monopoly property.[33] To see this, consider our setup without investments owners can make. Such a market is clearly a natural monopoly, any duplication of test costs is inefficient. There could easily be entry, and if so, prices would rise. Accordingly, such a simple setup with costly tests can also explain inefficient entry and rising prices. Nevertheless, it cannot cope with increasing damage rates. If there is entry in such a market, eventually all houses will pass the test somewhere and prices have to reflect this. The average damage rate in the economy stays, however, the same. In contrast, in our model the average damage rate goes up because there is too little investment. Adding positive test costs would, of course, increase the explanatory power of our model. For, say industrial fire insurance where the experts assessing the underlying risks are expensive, the natural monopoly property should be more likely to hold than for insurance branches where test costs are rather low. Positive test costs could also help to explain the fact that monopoly insurers have lower administrative costs than competitive insurers (see Appendix B). For each test the monopolist performs, he has a client; for insurers working in competitive environments this is typically not the case.

A final point is perhaps worth mentioning: Screening and testing will play

[33]So would any notion of fixed costs: with fixed costs there is only one active firm in the efficient market structure. We ruled out fixed costs in order not to blur our imperfect test phenomenon with other forces calling for a natural monopoly.

an ever more important role in other insurance markets, the prospects being greatest in health insurance where progress in genetic analysis may cause substantial changes. A better understanding of imperfect test procedures should thus be of interest beyond the rather narrow field of housing insurance.

Appendix A

Proof of Proposition 2: We have to distinguish between the subgames in which the incumbent keeps the entrant out and the subgames in which the incumbent accommodates entry. Suppose the incumbent charges limit prices $p_I \leq \min\{c_2^c, c_2^e - x\}$. If the entrant undercuts with $p_E < p_I$, she makes losses because $p_E < c_2^c$. If she charges $p_E = p_I$, she makes losses because $p_E < c_2^t$. If the entrant charges $p_E \in (p_I, p_I + x)$, she makes losses because $p_E < c_2^e$. If the entrant charges $p_E \geq p_I + x$, she makes zero profits because she either just breaks even or she has no customers. Given our selection rule, $p_E = p_{\max}(> h)$ is the best answer for the entrant if the incumbent picks a limit price $p_I \leq \min\{c_2^c, c_2^e - x\}$. Obviously, $p_I^\ell := \min\{c_2^c, c_2^e - x\}$ is the profit maximizing limit price. If the monopoly is not sustainable, i.e., if $x > c_2^e - c_1$, p_I^ℓ yields a loss of $c_2^e - x - c_1$. If, however, the monopoly is sustainable, p_I^ℓ yields a profit $\pi_I(p_I^\ell) = \min\{c_2^c, c_2^e - x\} - c_1 \geq 0$.

Now suppose the incumbent charges $\min\{c_2^c, c_2^e - x\} < p_I \leq p_{\max}$. With these prices the entrant can come in and make a profit. The entrant will never charge $p_E = p_I$. With that price she has half of the market and average damages c_2^t. She makes a profit $(p_E - c_2^t)/2$. If she undercuts the incumbent by ε, she has lower average damage $c_2^c < c_2^t$ and a larger clientele $\lambda(1 - q_h) + (1 - \lambda)(1 - q_l) + \lambda q_h^2 + (1 - \lambda)q_l^2 > 1/2$. Thus, for ε sufficiently small, undercutting p_I is better for the entrant than a tie.

Accordingly, the entrant either undercuts or takes the residual demand by quoting a higher price than the incumbent. In both cases the entrant's profits rise linearly in p_E up to the floor of $p_{\max}$. Therefore, the entrant either undercuts with the smallest possible amount, i.e., $p_E = p_I - \varepsilon$ or she takes the residual demand with the highest possible price $p_E = \min\{p_I + x,\ p_{\max}\}$.

If $p_I \leq c_2^c$, the entrant goes for the residual demand by charging $p_E = \min\{p_I + x,\ p_{\max}\}$. If $p_I = p_{\max}$, the entrant undercuts with $p_E = p_{\max} - \varepsilon$. Next note that if the entrant undercuts, her profits are also linear in the incumbent's price p_I because $p_E = p_I - \varepsilon$. Similarly, if the entrant goes for the residual demand, her profits rise linearly in p_I up to the floor of $p_{\max} - x$ where they remain constant because $p_E = \min\{p_I + x,\ p_{\max}\}$. From the intermediate value theorem we can, therefore, conclude that there exists a unique $\hat{p}_I \in (c_2^c, p_{\max})$ such that the entrant is indifferent between going for residual demand and undercutting. Formally, $\hat{p}_I$ is defined by

$$[\hat{p}_I - c_2^c][\lambda(1 - q_h) + (1 - \lambda)(1 - q_l) + \lambda q_h^2 + (1 - \lambda)q_l^2] =$$

$$[\min\{\hat{p}_I + x,\ p_{\max}\} - c_2^e][\lambda q_h(1-q_h) + (1-\lambda)q_l(1-q_l)] = \ :\hat{\pi}.$$

Call the associated profit $\hat{\pi}$. If the incumbent charges $p_I < \hat{p}_I$, the entrant goes for the residual demand and the incumbent's profits rise linearly in p_I. Thus, among these prices $\hat{p}_I$ is the best choice for the incumbent. With that price the incumbent makes profit $\hat{\pi}$ and so does the entrant.

If the incumbent charges $p_I > \hat{p}_I$, the entrant undercuts. The incumbent's profits are increasing in p_I so that $p_I = p_{\max}$ is the best choice. If $\min\{\hat{p}_I + x,\ p_{\max}\} = p_{\max}$, $\pi_I(\ p_{\max}) = \hat{\pi}$. If $\min\{\hat{p}_I + x,\ p_{\max}\} = \hat{p}_I + x$, $\pi_I(\ p_{\max}) > \hat{\pi}$. Thus, for $p_I > p_I^\ell$, given our selection rule, the incumbent accommodates entry by charging $p_I^a := p_{\max}$ which the entrant, in turn, undercuts with $p_E = p_{\max} - \varepsilon$. The incumbent's profit is $\pi_I(p_I^a) = (p_{\max} - c_2^e)[\lambda q_h(1-q_h) + (1-\lambda)q_l(1-q_l)]$. Consequently, if $\pi_I(p_I^\ell) > \pi_I(p_I^a)$, $p_I^* = p_I^\ell$ and $p_E^* = \ p_{\max}$; if $\pi_I(p_I^\ell) \leq \pi_I(p_I^a)$, $p_I^* = p_{\max}$ and $p_E^* = \ p_{\max} - \varepsilon$.

Q.E.D

Appendix B

The Swiss Housing Insurance Dispute: The dispute was essentially about three issues. First, damage rates, measured in centimes per 1000 francs insurance value, abbreviated ct/1000 fr. Average damage rates over the period 1984 - 1993 were 32.8 ct/1000 fr for the state monopolies and 55.1 ct/1000 fr for the private insurers. Here the private insurers argue that they operate mainly in the more risky mountain cantons and, therefore, have higher damage rates. Yet, even when we look at the disaggregate level and compare similar risks, the basic findings remain the same. In the privately insured mountain canton Obwalden the damage rate was 76.5 ct/1000 fr and in the neighboring publicly insured mountain canton Niwalden 56.9 ct/1000 fr. In the privately insured town Geneva the damage rate was 36.7 ct/1000 fr, in the publicly insured Zurich (and neighboring Lausanne) 18.3 (18.5) ct/1000 fr.

Second, the parties disagree on how to handle the surcharges on damage rates for fire prevention, overheads, and profits. Von Ungern-Sternberg considers the absolute values of 31.1 ct/1000 fr for the state monopolies and 53.9 ct/1000 fr for the private insurers. If we subtract from these surcharges the expenses for fire prevention, the difference becomes even more striking, 17.7 ct/1000 fr for the monopolies and 47.9 ct/1000 fr for the private insurers. Schips, in contrast, computes the ratio total premia/damage rates, giving rise to 164.3% for the private and 195.4% for the monopoly insurers. It is not entirely clear whether this ratio can be used to make meaningful comparisons; in any case it is favorable for insurers with high damage rates.

Third, the parties to the dispute ran several regressions to substantiate their claims. Here the interesting feature is that Schips works with unweighted regressions whereas von Ungern-Sternberg uses weighted regressions. This is important because the three small cantons Schaffhausen, Schwyz, and Uri with just 3% of all the buildings in Switzerland are extreme outliers in favor of Schips. Kirchgässner (1996) reruns Schips' unweighted regressions without these outliers, and obtains the opposite of his qualitative results. Moreover, Schips' regressions are insignificant with a negative R^2. Von Ungern-Sternberg's weighted regressions, by and large, validate his claims. For example, Kirchgässner obtains

$$\begin{array}{llllll} \textit{premium rate} = & 59.683 & + & 0.778 \, \textit{damage rate} & - & 20.472 \, \textit{dummy}, \\ & (7.27) & & (4.63) & & (5.07) \end{array}$$
$$R^2 = 0.641, \; SER = 16.01, \; J.B. = 0.387,$$

where SER measures the standard error of the regression and $J.B.$ gives the value of the Jarque-Bera-test for normality of the residuals. The dummy variable takes on 1 for monopoly cantons and 0 otherwise. Here the coefficient of the dummy variable tells us that, ceteris paribus, the premia of the monopoly insurers are 20 ct/1000 fr below the premia of private insurers.

Last but not least it is important to stress that neither Kirchgässner nor I were hired by any of the parties to the dispute, nor did we receive any payments. Our interest in this case is purely academic. Kirchgässner is mostly interested in the reasons that let Schips write his report from a public choice perspective.[34] I am interested in the stylized facts from an IO perspective. I have described the dispute for the following reason: Schips' attack in the end resulted in a broad consensus that there is really something to von Ungern-Sternberg's stylized facts.

[34] See, e.g., Cooter and Emons (2000) for a mechanism deterring slanted and false expert testimony including "junk science".

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