Minimum Coverage Regulation in Insurance Markets[1]

Daniel McFadden[2], Carlos Noton[3] and Pau Olivella[4]

July 30, 2013

[1]The authors thank Ramon Caminal and Mathias Kifmann, who discussed an earlier version of the paper, as well as participants in the Workshop in Game Theory of the Department of Economics at UAB, the Industrial Organization Workshop at IESE Business School, the ECHE conference in Zurich, and the seminars at the CRES of UPF, Universitat Pompeu Fabra and Universidad Complutense for their comments and suggestions. The usual disclaimer applies. McFadden acknowledges support from the E. Morris Cox fund at the University of California, Berkeley, the Presidential fund at USC, the Schaeffer Center for Health Economics and Policy at USC, and National Institute on Aging (NIA) grants No. P01 AG005842 to the NBER and No. RC4 AG039036 to USC; Olivella acknowledges support from the Ministerio de Educación y Ciencia, project ECO2009-07616, the ONCE Foundation, and the hospitality of the Institut d'Análisi Económica (CSIC)

[2]University of California, Berkeley and NBER. Department of Economics; 549 Evans Hall #3880; Berkeley, CA 94720-3880; USA . mcfadden@econ.berkeley.edu.

[3]University of Chile. Center for Applied Economics; Department of Industrial Engineering; University of Chile; Republica 701, Santiago, Chile; E-mail: cnoton@dii.uchile.cl

[4]Corresponding author. Universitat Autònoma de Barcelona and Barcelona GSE. Postal Address: Department of Economics and Economic History, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain; E-mail: pau.olivella@uab.es; Phone: +34935812369.

Abstract

We study the consequences of imposing a minimum coverage in an insurance market where enrollment is mandatory and agents have private information on their true risk type. If the regulation is not too stringent, the equilibrium is separating in which a single firm monopolizes the high risks while the rest attract the low risks, all at positive profits. Hence individuals, regardless of their type, "subsidize" insurers. If the legislation is sufficiently stringent the equilibrium is pooling, all firms just break even and low risks subsidize high risks. None of these results require resorting to non-Nash equilibrium notions.

KEY WORDS: health insurance; mandatory enrollment, minimum coverage regulation, asymmetric information; market equilibrium; cross-subsidization

1 Introduction

A widespread regulation in the private health insurance industry is the existence of a minimum standard, which puts a lower bound on the coverage that can be offered to agents in different services. Most states in the US consider legal mandates for health insurance in the individual and small group markets.[1] Importantly, there are large differences in both the number of mandates across states and their estimated cost. Figure 1 depicts these findings based on Keating (2011) and Bunce and Wieske (2010).[2] How stringent the legislation should be is of a great importance since US authorities have to establish the minimum standards nationwide as signed in the federal legislation.

Figure 1: Mandates and Cost Heterogeneity across States in the US

As it turns out, this regulation comes at the expense of low risks. Hence it is often accompanied by mandatory enrollment laws, whereby all individuals are forced to pick one of the outstanding contracts in the market. This indeed is the case in Patient Protection and Accountable Care Act of 2010 (PPACA)[3] that is in the process of implementation at the time of writing this paper.

One of the arguments for such regulation is the underprovision of coverage for a large segment of the population. This phenomenon can be caused by several reasons,[4] but here we focus on the presence of asymmetric information between insurers and insurees, which has attracted a great deal of attention for more than thirty years. Since the seminal work of Rothschild and Stiglitz (1976) (henceforth RS), it is well known that when individuals have privileged information on their own health risks, the market will respond by providing a set of contracts, one intended for low risks with low coverage and low premium, and the other

[1] This regulation does not apply to health maintenance organizations (HMOs), preferred provider organizations (PPOs), or self-funded large group markets. Similar regulations are imposed in European countries with a sizable private sector in health insurance, such as Germany and the Netherlands, or in some sectors like civil servants in Spain. However, in these cases the individual does not directly pay an out-of-pocket premium to the insurer. Instead, individual contributions go to a common fund that is then used to pay health plans on a risk-adjusted/per-enrolee basis (capitation).

[2] This paper does not seek the causes of the heterogeneity, but to study consequences of this pervasive regulation.

[3] Commonly, "Obamacare". The minimum coverage takes the form of the so called the Bronce Plan, characterized by a maximum deductible of $2000 and a 50% of maximum coinsurance.

[4] Ex ante or ex-post moral hazard, consumers' misperceptions of risk, performance risk, and so on. See McFadden, Noton, and Olivella (2012) for a review.

contract intended for high risks with full coverage and high premium.

The fact that high risks are forced to pay a high premium is seen as unfair to many analysts and regulators. Hence, many researchers have been devoted to find ways to regulate this market in order to implement some degree of cross-subsidization. An extreme form of such cross-subsidization is present in a pooling equilibrium, where all risks obtain the same coverage at the same premium, regardless of their risk.[5] RS also showed that no such pooling equilibrium can exist in the absence of regulation, since one of the insurers can profitably deviate by offering a contract with a slightly cheaper premium and lower coverage, which will only attract the low risks. This action is labeled as "cream skimming" (also known as "cherry picking").

Our aim is to determine whether a minimum coverage legislation (henceforth MCL) can allow cross-subsidization. The idea is that undesirable cream skimming deviations might be ruled out through such legislation. As mentioned above, since cross-subsidization comes at the expense of low risks, such legislation is often accompanied by mandatory enrollment laws.

Using the model of RS as a benchmark, we show that the effects of MCL drastically depend on how demanding this regulation is. In a nutshell, our main result is that a weak MCL could bring an unexpected result. Namely, insurers might increase their profits while *all* types of individuals might be worse off. In other words, a weak MCL may result in individuals subsidizing the insurers rather than low-risks subsidizing high-risks. In contrast, a sufficiently stringent MCL can indeed restore the desired cross-subsidization from low risks to high risks while all firms make zero profits.

We focus on single contract competition based on three arguments that suggest that it maybe difficult for a single insurer to implement a perfect screening menu by itself.

First, the large costs of bargaining with specialized networks can make less attractive to serve all types. In fact, there is evidence of an increasing specialization in hospitals and care providers (Tiwari and Heese (2009), Schneider, Miller, Ohsfeldt, Morrisey, Zelner, and Li (2008)). The trend is to switch from large hospitals (who pool all risk types) towards smaller and more focused healthcare centers specialized in particular diagnosis.[6] The widespread claim is that specialty hospitals focus

[5]This is conditional on risk class. A risk class is the set of individuals sharing the same value of their observables used to underwrite contracts (usually demographics such as age and gender).

[6]See Vanberkel, Boucherie, Hans, Hurink, and Litvak (2012) and Mahar, Bretthauer, and Salzarulo (2011) for technological and economic causes behind this trend.

on profitable low-risk patients offering a better service following a cream-skimming strategy, leaving the high-risk cases to large hospitals. In this context, we believe that insurers also tend to specialize, since bargaining with many networks of specialized health services providers should decrease the profitability of serving all types.[7] Unfortunately, detailed market share data at plan level per insurer are usually not available to researchers to either support or reject this hypothesis. Thus, our results apply whenever there is a main plan per provider, which resembles single contract competition.

Second, the large transaction and screening costs at firm level can make less attractive to serve all types, as pointed out by Pauly (2012). In his words:

> [of course managed competition wanted to take risk variation out of the problem, but I strongly suspect, based on page after page in the ACA, that doing so is more trouble than it's worth.]

Third, a screening menu may entail a very asymmetric treatment of customers within the same insurance company. Offering full coverage to some and partial coverage to others may have a negative impact on the perception of the provider by society. Thus, ethical limitations could also discourage menu competition.

The closest paper to ours is by Neudeck and Podczeck (1996) (henceforth NP). They were the first authors to point out that a weak MCL could have perverse effects. However, our analysis and results differ from theirs in several respects. First and foremost, their results are less dramatic than ours. Namely, they focused on an equilibrium where only insurers attracting low risks make positive profits (p. 400), whereas we show existence of an equilibrium where all firms make positive profits and all individuals are worse-off –even the high risks– as compared to the laissez faire. Second, their result is based on the use of a non-Nash equilibrium notion, namely, Grossman Equilibrium, a point that we return to below, whereas we stick to the Nash concept.[8] Finally, their prediction on the equilibrium market structure is quite imprecise. Except from exhibiting a separating equilibrium, there is no prediction regarding how many insurers are offering each contract in the separating

[7] For stylized facts on the bargaining between hospitals and PPO see Morrisey (2001) and the cites therein.

[8] Many other papers have abandoned the Nash equilibrium notion in order to formulate predictions in a model where firms are allowed to offer menus of contracts. Indeed, as shown by (Encinosa 2001), a Nash equilibrium fails to exist under a weak MCL if firms are allowed to offer menus.

set. In contrast, we are able to predict a unique market structure that is fully spelled out below.[9]

The comment on NP by Encinosa (2001) also focuses on MCL. Instead of Grossman's equilibrium notion, he takes two independent alternatives to restore equilibrium. The first one is to use another equilibrium notion, namely the Wilson-Miyazaki-Spence (WMS) equilibrium notion.[10] The second one is to stick to Nash equilibrium notion but assume that (i) insurers offer contracts in a limited amount (or "capacity", in his terminology) and that (ii) there is a sufficiently large proportion of high risks in the population.[11] He concludes that, under both alternatives, there is a menu equilibrium that is second best and where insurers make zero profits. We prefer to stick to the Nash equilibrium notion and not assume any capacity constraints.

On the empirical literature of MCL, Finkelstein (2004) studies the effects of minimum standards in the Medigap market that took place during the late 70's. She finds evidence of a substantial decrease in the (voluntary) enrollment, especially for the most vulnerable population. More related to our paper, she finds evidence consistent with a change in the nature of equilibrium from separating to pooling equilibrium. Her findings are along the same lines of the model presented by NP and are also consistent with our findings.

Let us now present our results in detail. We make two working assumptions. First, an exogenous number of firms strictly larger than 3 serve this market.[12] Second, the proportion of low risks is below the

[9] Another difference between our analysis and NP's (and the rest of the literature for that matter) lies in the interpretation of "minimum mandates". Namely, NP assume that this regulation implies the restriction that coverage and premia are such that all individuals attain a minimum level of welfare in the event of illness. We consider that only the coverage is regulated under MCL. We show in Appendix 3 that our results also hold in this other case.

[10] See Encinosa (2001) for details. The equilibrium menus under a MCL involve cross-subsidization. Such cross subsidization can be supported using WMS equilibrium because if a firm drops the loss-making contract it induces losses on the rest, who automatically withdraw their contracts.

[11] Intuitively, when a firm drops the contract aimed at attracting the high risks (which is the contract that makes losses), the high risk individuals that are left without a contract randomly seek the outstanding contracts. Hence the deviating firm ends up serving some high risks at his contract aimed at low risks, which induces large losses on that firm. (See Appendix A in Encinosa (2001).)

[12] If the market is served by a (specialized) duopoly, that is, a single firm offers the contract aimed at the high risks and a single firm offers the contract aimed at the low risks, the equilibrium becomes undetermined, as pointed pout by Villeneuve (2003). The idea is that the low-risk's incentive compatibility constraint at the contract aimed to the low risk is not binding, so a voluntary participation constraint would have to be imposed to close the model. Existence of an equilibrium after imposing such a

threshold for existence in the RS model, which we refer to as the RS threshold. This ensures existence of a *laissez faire* equilibrium. As in RS, we have a two stage game. In the first stage, insurers offer their contracts simultaneously. In the second stage, individuals choose one of the outstanding contracts in the market. By backward induction, once the optimal choice by individuals among any possible profile of contract offers has been determined, we use the Nash equilibrium notion to find the equilibrium set of contracts. Hence, we do not restrict deviations by an insurer to be robust to further deviations by other insurers.[13] Also, unlike Grossman's notion, we do not allow insurers to withdraw contracts that were previously offered.[14]

If there is no binding MCL, the standard separating equilibrium of RS is found. As soon as the MCL becomes binding, there exists an open set of parameter values such that there exists an equilibrium where all firms make identical strictly positive profits. This equilibrium is still separating and coexists with the equilibrium studied by NP for any given vector of parameter values. In both equilibria, a single firm, which we name "the scapegoat" for reasons that will become clear below, attracts all the high risks in the population while the rest of firms (more than one given our assumption) "free ride" on the scapegoat to obtain profits at least as large as the scapegoat's. In the NP equilibrium, the high risks enjoy the same contract as under laissez faire, which in turn coincides with the one that obtains under symmetric information. In the new equilibrium that we find, the high risks pay a higher premium than under laissez faire but still enjoy full coverage. Hence the scapegoat obtains positive profits as well.

In contrast, if the MCL is sufficiently demanding, then a pooling equilibrium, where all insurers offer the same contract, is the only possible equilibrium. In this equilibrium all firms make zero profits and the desired cross-subsidization from high to low risks is attained. Obviously, as compared to the laissez faire, low risks are worse off and high risks are better off. Notice however that the low risks are always worse-off no matter how stringent the MCL is.

The intuition for the result arising under a weak MCL is the following. The same legislation that impedes cream skimming deviations also has a severe anti-competitive effect. Suppose all free riders make positive

constraint is still an open question.

[13]In Wilson's notion, firms who make losses after a deviation are allowed to withdraw their contracts. In Riley's notion, potential firms who could make profits after an incumbent's deviation are allowed to offer a new contract.

[14]In Grossman's notion, insurers who have learned the type of the individual by her choice of contract are allowed to withdraw the contracts that would yield losses.

profits. A free rider trying to undercut his free-rider rivals can only do so by decreasing his premium, due to the MCL. This breaks separation and the deviation becomes unprofitable. What is new in our analysis is the following additional intuition. Suppose that the scapegoat also enjoys positive profits. Obviously, he is not going to undercut himself. If he tries to undercut the free riders then again separation is broken and the deviation becomes unprofitable. Lastly, we need to ensure that a free rider does not want to undercut the scapegoat. Hence our result that in equilibrium, free riders obtain no less profits than the scapegoat, which in turn (perhaps) justifies our terminology.

To sum up, our contribution is two fold. First, we are able to sustain the equilibrium studied by NP without having to resort to non-Nash equilibrium notions. Interestingly, this allows us to be much more precise in our prediction of the market structure that will arise. Second, we show that this market structure is compatible with other equilibria where also the insurer serving the high risks makes positive profits.

We have also analyzed a variation of the game described above where a large set of potential insurers, in the first stage of the game, not only choose their contract but also whether to offer a contract at all. If they do offer a contract they must bear some fixed (entry) cost.[15] Hence the number of insurers becomes endogenous. Unfortunately, in such a model, Nash Equilibria in the entry stage never exist under *laissez faire*. Interestingly, however, introducing a MCL may allow for the existence of such equilibria. The idea is that, as mentioned above, there exists a middle range of MCL where a finite number of firms obtain positive (variable) profits. This allows these firms to recover the entry costs and we can sustain an equilibrium that is separating with the structure described above (one scapegoat and at least 2 free riders).

The paper is organized as follows. In Section 2 we introduce the game and the equilibrium notion and we present the benchmark case of RS. In Section 3 we solve the game. In Section 4 we introduce the game where firms choose whether to enter or not and sustain equilibria for a range of minimum coverage levels. Section 5 concludes. Proof of all lemmas and propositions are relegated to the appendix.

2 The model

We use the model of RS as the benchmark. Suppose a population of risk averse consumers who are homogenous except in their probability

[15] Encinosa and Sappington (1997) analyze the nature of competition between two HMOs bearing asymmetric fixed costs. They consider both the level of preventive care and the level of treatment. Hence their model constitutes a very important departure form RS model. We prefer to stick to RS as much as possible.

of falling sick. The probabilities have two possible values: p_H and p_L with $0 < p_L < p_H < 1$. The subpopulations are named high-risks and low-risks accordingly. The risk type is private information. The share of the low risk types in the population is public knowledge and denoted by $0 < \lambda < 1$. Consequently, the average probability $\bar{p}$ is given by $\bar{p} = (1-\lambda)p_H + \lambda p_L$.

As it is customary in the literature, we use the final wealth representation to derive our results and to draw figures. Let s and n be the final wealth if the individual is sick and healthy respectively. The expected utility function V^i of type $i \in \{L, H\}$ is given by $V^i(s,n) = (1-p_i)U(n) + p_i U(s)$ with $U'(\cdot) > 0$ and $U''(\cdot) < 0$. The marginal rate of substitution of type i is given by:

$$MRS_i = \frac{\frac{\partial V^i}{\partial n}}{\frac{\partial V^i}{\partial s}} = \frac{(1-p_i)}{p_i}\frac{U'(n)}{U'(s)}.$$

The direct consequences of becoming sick are represented by a loss in wealth $\ell > 0$. The initial wealth is $w > 0$. Thus, the two potential future states of the world for an uninsured individual are $n = w$ if remains healthy and $s = w - \ell$ if he becomes sick We refer to this uninsured situation as the *status quo* point and is denoted by A.

A contract in this market is defined by a pair $C = (c, \widetilde{P})$, where c denotes the coverage and $\widetilde{P}$ denotes the premium charged by the insurer to the agent. The insurer is risk neutral and the expected profit given by a contract with type i consumer is $(1-p_i)\widetilde{P} + p_i\left(\widetilde{P} - c\right) = \widetilde{P} - p_i c$.

Since we work in the final wealth space, we perform the usual change of variable.[16] If an individual has purchased a contract $(\widetilde{P}, c)$, his final wealths are either $s = w - \ell - \widetilde{P} + c$ or $n = w - \widetilde{P}$. Notice that these two equations are independent of the risk type. Using the previous expression for s and n, an insurer attracting a type i individual with a contract (n, s) expects to obtain per capita profits equal to

$$\pi_i(n,s) = w - n - p_i\left(s - n + \ell\right). \tag{1}$$

Similarly, an insurer attracting an unbiased mix of the both risks expects to obtain

$$\bar{\pi}(n,s) = w - n - \bar{p}\left(s - n + \ell\right).$$

Thus, isoprofits associated to an individual of type $i = L, H$ have slope $ds/dn = -(1-p_i)/p_i$ in the (n,s) space. It is easy to check that the zero isoprofit goes through *status quo* point A. The zero isoprofits associated to each type are depicted in Figure 2 as the two straight lines. From

[16] See Appendix 1 for details.

now on, we express contracts (n, s) in the final wealth space. Finally, we use Π to represent the total profits obtained by a firm.

As proven by RS, the equilibrium outcome under *symmetric* information is given by the contracts H^* (for high risks) and L^* (for low risks) in Figure 2, where attracting any type yields zero profits and contracts are efficient, that is, both contracts offer full insurance so $n_i = s_i$ for all $i = L, H$.

Figure 2: The Equilibrium under Symmetric Information

Of course, the high risks would be better off if they could have the contract intended for low risks. This is the basic nature of the adverse selection: some agents have the incentives to hide their type.

As also proven by RS, the only possible equilibrium under *asymmetric* information has two separating contracts $\{H^*, L^{RS}\}$ being offered in the market, and determined by four equations, namely, zero expected profits for insurers offering L^{RS}, idem for insurers offering full insurance at H^*, and binding incentive compatibility constraint for the high-risks. Mathematically,

$$\pi_L (n_L, s_L) = 0; \tag{2}$$

$$\pi_H (n_H, s_H) = 0; \tag{3}$$

$$s_H = n_H; \tag{4}$$

$$V^H (n_H, s_H) = V^H (n_L, s_L) . \tag{5}$$

The two contracts are depicted in Figure 3, where the first contract has high-premium-high-coverage, intended for the high risk type; while the second has low-premium-low-coverage and is intended for the low risk type. Denote the coverage associated to the latter contract by c_L^{RS}. Incidentally, Figure 3 is depicted for $p_L = 1/5$, so the slope of the corresponding zero isoprofit is 4; $p_H = 4/5$, so the slope of the corresponding zero isoprofit is $1/4$.

Figure 3: The Equilibrium under Asymmetric Information

One important insight of RS is that equilibrium does not exist if the proportion of low risks λ exceeds a threshold denoted λ^{RS}. The threshold ensures that the indifference curve of the low-risks at L^{RS} does not cross the zero isoprofit line of the fair pooling contracts, which we denote by $\pi^P(\Pi = 0)$. In the next sections, we show that existence of an equilibrium is compromised under MCL even if $\lambda < \lambda^{RS}$.

2.1 The game and the equilibrium notion

There are N individuals in this market. Risk type is private information while the proportion of low risks, λ, is common knowledge. Denote the zero isoprofit line associated to an unbiased mix of the entire population by $\pi^P(\Pi = 0)$. The set of insurance providers is exogenously given. Denote this set by $\Phi = \{1, 2, .., k, .., M\}$. In Stage 1, each insurer $k \in \Phi$ decides which contract, $S_k = (n_k, s_k) \in \Re^2_+$, to offer. All insurers take this decision simultaneously. Let $\Sigma = \{S_1, S_2, ...S_\sigma\}$ be the set of *different* outstanding contracts. In Stage 2, each consumer chooses one contract in Σ. Let $g : \Phi \to \Sigma \times \mathbb{N}^2$ be an anonymous matching function that assigns, to each firm k in Φ, one of the contracts S_k in Σ and two natural numbers: the number of individuals n_L of type L and the number n_H of individuals of type H that will accept firm k's contract. We now introduce our equilibrium concept.

Definition 1. *Given any pre-specified set of firms Φ, we say that the pair $\{\Sigma, g\}$ constitutes a Competitive Nash Equilibrium (CNE) if no firm in Φ can obtain larger profits than in the status quo by offering a contract $S' \notin \Sigma$.*

Notice that we are assuming a compulsory insurance scheme. Thus,we do not include a voluntary participation constraint (VPC) in our model.

2.2 Recasting RS

We can cast RS model as a particular case of our game. The only requirements are that the number of insurers M being strictly larger than 2 and the absence of a binding MCL. Due to the constant returns to scale, the equilibrium can be sustained with any arbitrary number of firms offering any of the two contracts as long as at least 2 offer contract L^{RS}. In our notation, the CNE is given by (i) $\Sigma = \left\{H^*, L^{RS}\right\}$, (ii) *any* partition of Φ into two subsets Φ_L and Φ_H with the only constraints that $|\Phi_L| \geq 2$ and that $|\Phi_H| \geq 1$, and (iii) $g(i) = \left(H^*, 0, \frac{(1-\lambda)N}{|\Phi_H|}\right)$ for all $i \in \Phi_H$ and $g(i) = \left(L^{RS}, \frac{\lambda N}{|\Phi_L|}, 0\right)$ for all $i \in \Phi_L$. We say that this is an equilibrium with *full specialization* (Olivella and Vera-Hernandez 2010).

Lets us explain the requirement of $M \geq 3$.[17] If there are only two firms, the RS equilibrium is not robust to a deviation by *the* firm offering the contract L^{RS}. This deviation consists in raising the premium of L^{RS}. Incentive compatibility (IC) is preserved (since the low risk IC constraint

[17] This was first pointed out by Villeneuve (2003) and formally proven by Olivella and Vera-Hernandez (2010).

was slack at L^{RS}) and there is no rival also offering L^{RS} to rule out this deviation.

Finally, we show why an equilibrium with positive profits cannot be sustained even if M is only equal to 3. Consider for instance the pair of contracts $\{H^{*}, L'\}$ depicted in Figure 3. One firm, say firm 1, offers contract H^{*} and the rest of firms offer contract L'. Then Firm 2 (or 3) could gain through a cream-skimming deviation by offering a contract in the wedge formed by indifference curves $V^{H}(H^{*})$ and $V^{L}(L')$. We emphasize this very standard argument of cream-skimming deviations because this is precisely the deviation we can rule out in the presence of MCL. This in turn allows us to sustain equilibria with positive profits. Hence, the same type of legislation has very effects depending on how restrictive the legislation is: if it is sufficiently stringent it sustains cross-subsidization from the low to the high risk (namely a pooling equilibrium); if it is sufficiently weak it sustains cross-subsidization from all individuals to all insurers.

2.3 General Isoprofit Lines

Since we will deal with equilibria with positive profits, we need to identify the corresponding isoprofit lines. Hence, in this section we derive the position of the isoprofits associated to an arbitrary level, say $\Pi \geq 0$, of profits. Obviously, a larger profit requires a parallel shift downwards with respect to the initial zero isoprofit line. We assume that individuals split equally among firms if attracted by a contract that is offered by more than one firm. Since isoprofits are depicted in the space of individual contracts, the shift due to raising profits from zero to Π will also depend on both the number and mix of individuals accepting the contract. In contrast, we prove below that the slope of the isoprofits only depends on the risk mix.

To ease notation, let

$$\alpha = \Pi/N,$$

where N is the number of consumers. We label the isoprofit associated to contracts that yield profits Π by π^{Jm}, where $J \in \{L, H, P\}$ indicates the risk-mix of the insurees (it suffices to distinguish between these three risk mix configurations: low risks only, high risks only, and pooling) and m indicates the number of firms offering a given set of contracts in the isoprofit. The next lemma establishes the slope and position of such isoprofits. The position is established using, as a reference point, the contract associated to the absence of coverage, i.e., $c = 0$ and $(n, a) = \left(w - \widetilde{P}, w - \widetilde{P} - \ell\right)$. We denote this point by A^{Jm}, $J \in \{L, H, P\}$, $m \in \{1, ..., M\}$. For instance, if a single firm is attracting all high risks, then the reference point is denoted by A^{H1} and the isoprofit by π^{H1}. Notice that if Π is set to zero then $c = 0$ implies $\widetilde{P} = 0$ and $A^{Jm} = (w, w - \ell) = A$ for all $J \in \{L, H, P\}$ and $m \in \{1, ..., M\}$.

Lemma 1 *For any $\Pi > 0$, point A^{JM} is located at a South West (45°) positive distance from the status quo point $A = (w, w - \ell)$. The distance between A and A^{Pm} is αm; the distance between A and A^{Lm} is $\frac{\alpha m}{\lambda}$; and the distance between A and A^{Hm} is $\frac{\alpha m}{1-\lambda}$. Isoprofit line π^{Jm} has slope $-\frac{1-p_J}{p_J}$ for $J = \{L, H, P\}$ for any $m \in \{1, ..., M\}$.*

In general, contract A^{Pm} is always to the North-East of both contract A^{Hm} and contract A^{Lm} for any m, because pooling the entire population ensures a larger mass of consumers to attain the same profit. Instead, the relative position of A^{Hm} and A^{Lm} depends on the proportion λ. To illustrate this, Figure 4 shows the different isoprofit lines associated to some $\Pi > 0$ for a number of firms $m = \{1, 2, 3\}$ that are specialized in attracting low-risks. As mentioned, the slopes remain equal to $ds/dn = -(1 - p_L)/p_L$. The distances between each isoprofit and the status quo are $\{\alpha/\lambda, 2\alpha/\lambda, 3\alpha/\lambda\}$ .To provide the full variety of cases, Figure 5 depicts isoprofit lines for different risk mixes and different numbers of providers for $\lambda = 1/3$. Since $\lambda < 1/2$, the distance between A and A^{L1} (here, $\frac{\alpha}{1/3} = 3\alpha$) is larger than the distance between A and A^{H1} (here, $\frac{\alpha}{1-1/3} = \frac{3}{2}\alpha$).

Figure 4: Isoprofit lines associated to a fixed positive profit by a contract attracting only L-risks, offered by $m = 1, 2, 3$ firms

Figure 5: Isoprofit lines associated to a fixed positive profit for various risk mix and number of firms for $\lambda = 1/3$.

2.4 Minimum Coverage Regulation

This paper focuses on the consequences of a mandatory minimum coverage in the model, hence we provide the graphical illustration of the region that is restricted due to the regulation.

To fix ideas, suppose first that a regulation sets a *fixed* coverage c^*. Only the premium can vary and the feasible contracts can only be in a given 45 degree line since changes in premium affect equally both final wealth levels. Notice that under a fully fixed coverage regulation there is no self-selection possible. If two contracts have the same coverage and different premia, only the low premium contract is chosen by the agents.

Consider now that regulation sets a *minimum* coverage, so that $c \geq c^*$. Hence any contract on or above the 45 degree limit line is legal. Figure 6 illustrates this situation.

Figure 6: Minimum Coverage Regions for a given c*.

The literature has identified minimum standard regulation with restricting insurers to guarantee a minimum wealth in case of the bad outcome for the insuree (Neudeck and Podczeck (1996), Encinosa (2001), Finkelstein (2004)). We also studied this alternative regulation and our findings still hold (see Appendix 3 for details).

3 Solving the game

Assume a fixed number of firms $M > 2$ operate in the market. First, we prove a useful lemma, which provides necessary conditions for a *separating* CNE.

Lemma 2 *Under a binding MCL ($c^* > c_L^{RS}$), any separating pair of contracts (H, L), where H is the contract aimed to attract high risks and L the contract aimed to attract the low risks, is a CNE only if it satisfies the following conditions:*
(i) Contract H offers full coverage.
(ii) Contract L lies in the intersection between the minimum coverage line and the high risk's indifference curve through H.
(iii) At least two firms offer L, each one at total profit that we denote by Π_i^L.
(iv) Exactly one firm (henceforth Firm 1 without loss of generality) offers H at profit that we denote Π^H.
(v) $\Pi_i^L \geq \Pi^H \geq 0$.

A very important consequence of this Lemma is that equilibrium candidates are parameterized by the premium offered at H. Since coverage at H is full, its position in the 45^o line is determined by the premium. This also determines per-capita profits derived by Firm 1 at H, or π^H, as well as its total profits $\Pi^H = (1 - \lambda) N\pi^H$. Hence we state that the equilibrium candidates are parameterized by Π^H. Once the position of H is given, we find the high-risk indifference curve going through it. This curve altogether with the minimum coverage line gives the exact position of L and also the per capita profits obtained at this contract, π^L. The total *industry* profits obtained at L are $\lambda N\pi^L$ which are split among the $(M - 1)$ firms offering L, i.e., $\Pi_i^L = \lambda N\pi^L/(M - 1)$. Notice that as Π^H increases (and H slides down the 45^o line), the corresponding L contract also slides down on the minimum coverage line. This implies that also π^L is increasing as Π^H increases. Hence there exists a monotonically increasing function ϕ that relates firms' profits in the following fashion:

$\Pi_i^L = \frac{\lambda N \phi\left(\Pi^H\right)}{M-1}$. It is easy to see that $\phi(0)$ takes a positive value. Indeed, if $\Pi^H = 0$ then contract H becomes the same contract as under symmetric information, H^*. The high risk indifference curve through H^* intersects the minimum coverage line (if MCL is binding) to the South West of the contract aimed to low risks under laissez faire, or L^{RS} (the RS separating equilibrium). Since profits are zero at L^{RS}, profits at L must be positive. Notice also that $0 < \frac{\partial \Pi_i^L}{\partial \Pi^H} = \frac{\lambda N \phi'\left(\Pi^H\right)}{M-1}$ so that, for sufficiently small λ and/or sufficiently large M, we also have $\frac{\partial \Pi_i^L}{\partial \Pi^H} < 1$. The facts that $\frac{\lambda N \phi(0)}{M-1} > 0$ and that $\frac{\partial \Pi_i^L}{\partial \Pi^H} < 1$ jointly imply that there exists a unique $\hat{\Pi}^H$ such that $\Pi_i^L = \frac{\lambda N \phi\left(\hat{\Pi}^H\right)}{M-1} = \hat{\Pi}^H$, that is, a unique fixed point in the relation between the two profits. A corollary of Lemma 2 then is that the continuum of equilibrium candidates is characterized by Π^H in the closed interval $\left[0, \hat{\Pi}^H\right]$. Higher profits at H cannot be sustained since condition (iv) in Lemma would be violated.

Lemma 2 only provides necessary conditions for existence of a separating equilibrium. We now construct such equilibria for a given MCL. The fact that there may exist separating candidates where profits are positive was already shown by NP, but in the equilibrium they focused on only firms attracting low risks enjoyed such profits. We show next that in fact it is possible to support an equilibrium where $\Pi_i^L = \Pi^H = \hat{\Pi}^H > 0$.

Consider Figure 7, where we give an example using $\lambda = 1/2$, $p_L = 1/5$ and $p_H = 4/5$, so that $\bar{p} = \frac{1}{2}\frac{1}{5} + \frac{1}{2}\frac{4}{5} = \frac{1}{2}$ and the slope of π^{P1} is $\frac{1-\bar{p}}{\bar{p}} = 1$.

Figure 7. The CNE under Minimum Coverage Legislation

Consider first contracts H^{1a} and L^{2a}, where numerical superscripts denote the number of firms offering that contract. Assume $M = 3$. Firm 1 is offering contract H^{1a} (so we say $M_H = 1$) at profits $\Pi > 0$ while $M_L = 2$ insurers offer contract L^{2a}. As depicted, these insurers also make profits Π. To see this, notice first that there exists a positive distance α from A^{P1a} to A. This distance entails profits per capita equal to α for any contract in the isoprofit $\pi^{P1}(\Pi > 0)$ stemming from A^{P1a} as long it is a pooling monopoly. Hence $\Pi = \alpha N$. Now, A^{H1a} is at twice the distance α. Hence profits per capita would be doubled at contracts on the isoprofit π^{H1a} stemming from A^{H1a} if all individuals in the economy where high risks and where attracted by the same firm. However, only half of them are high risks. But they are indeed attracted by Firm 1 only, so Firm 1 makes profits Π. Finally, notice that A^{L2a} lies at four times the distance α. Profits per capita are quadrupled at π^{L2a} but only low risks are attracted (half of the population since $\lambda = 1/2$) plus two firms must share this low risk population. Hence Firms 2 and 3 make profits Π as well. This is our fixed point in the relationship between Π_i^L and Π^H. Importantly, we have made an assumption on the utility function ensuring that no profitable monopolizing pooling deviations exists. Isoprofit $\pi^{P1}(\Pi > 0)$ does not intersect the low risk indifference curve through L (labelled $V^L(L)$). Notice also that mandatory enrollment is binding for the low risk. If insurance was voluntary, the low risk might not purchase it.

Let us consider all possible deviations from this CNE candidate. Firm 1 cannot deviate to any other contract without either loosing all of its clients (here the fact that the high-risk incentive-compatibility constraint is binding becomes crucial), or making less profits, or becoming a pooling monopoly (which we have already shown is unprofitable). Firms 2 or 3 cannot offer a contract with a higher premium and the same coverage without loosing their clients, since more than one firm is offering contract L (in other words, the rival disciplines the deviant firm). If any of these firms offers a contract with more coverage or lower premia, it attracts all high risks, becoming a pooling monopoly. The only alternative deviation left is that either firm 2 or firm 3 undercuts firm 1, that is, it offers full coverage with a slight lower premium. However, the most that such a deviation can yield is profits Π, and therefore is not profitable.

The equilibrium studied by NP is given by the pair of contracts $\left(H^*, L^{2b}\right)$, where $\Pi_i^L > 0$ while $\Pi^H = 0$. It is easy to check that it is sustained by the same market structure: Firm 1 offers H^* while two firms offer L^{2b}. However, notice that now one can have any arbitrary number of firms offering L^{2b} since it is always the case that $0 = \Pi^H < \Pi_i^L$ so condition (v) in the lemma is always satisfied. Note that Π_i^L is lower than under the previous CNE, but positive and therefore higher than under laissez-faire. This is the other extreme case in the continua of CNE candidates. To ensure that no profitable pooling deviation exists we have depicted the zero isoprofit line associated to the zero profit pooling contract, which stems from point A. Notice that the low risk indifference curve trough L^{2b} does not intersect this isoprofit.

As we did for the RS separating equilibrium (or *laissez faire*) we now use our definitions to express this result more formally:

Proposition 3 *Suppose that* $\Phi = \{1, 2, 3\}$. *Under a sufficiently weak MCL it is possible to construct at least two CNE. One is given by* $\Sigma = \{L^{2a}, H^{1a}\}$ *and* $g(1) = (H^{1a}, 0, (1-\lambda) N)$; $g(2) = g(3) = \left(L^{2a}, \frac{\lambda N_L}{2}, 0\right)$; *where all firms make the same profits* $\Pi > 0$. *The other is given by* $\Sigma = \left\{L^{2b}, H^*\right\}$ *and* $g(1) = (H^*, 0, (1-\lambda) N)$; $g(2) = g(3) = \left(L^{2b}, \frac{\lambda N_L}{2}, 0\right)$; *where only firms 2 and 3 make profits* $0 < \Pi' < \Pi$.

Also in Figure 7 we have depicted the continuum of equilibrium candidates, that is, the pairs of contracts fulfilling the necessary conditions spelled in Lemma 1. They are stressed by two thick double pointed arrows. For each contract in the arrow at the 45^o line, aimed to high risks, the corresponding incentive compatible contract aimed at low risks is found in the arrow at the minimum coverage line. Notice that it is always the case that per firm profits are larger at the L contract than in the H contract.

This analysis has been carried for a specific level of minimum coverage. For lower coverage level the analysis remains intact. Also, it does for larger MCL as long as the set contracts (L^{2a}, H^{1a}) associated with the fixed point $\Pi_i^L(\Pi^H) = \Pi^H$ satisfies that no profitable pooling deviation exists. This will be the case as long as the minimum coverage is not too high. In the next section we show that for a sufficiently large MCL the unique MCL is a pooling equilibrium.

To conclude, we have shown that a weak MCL could have unintended results in this market. All firms may obtain positive profits and all risks may be worse off as compared to the laissez faire. Whereas NP already warned that introducing a MCL did not necessarily imply a cross-subsidization from low risks to high risks (in their equilibrium high risks enjoy the same contract as under laissez faire), we point out that the outcome could be even worse: *all* individual types cross subsidize *all* firms.

3.1 Sustaining a Pooling equilibrium

Suppose that the MCL is stringent enough that the crossing between the minimum coverage line and the high risk indifference curve at H^*, or $V^H(H^*)$, lies exactly at the zero pooling isoprofit line. This situation is depicted in Figure 8. This level of MCL, $c^* = c^P$, is the lowest mandatory coverage possible consistent with a pooling equilibrium. Notice that the separating candidate (H^*, L) is still a CNE as long as at least two firms offer contract L. But all firms offering L is also a pooling equilibrium. The reason is simple, the usual cream skimming deviations are ruled out by the MCL.

As the MCL becomes even more stringent, say $c^* = c' > c^P$, the separating candidate (the pair (H^*, L') in Figure 8) is no longer robust to a pooling deviation, namely a contract in the interior of the segment PL', which yields positive profits. In that case the only CNE is the pooling contract (contract P in Figure 8). In this case the redistributive aim is perfectly fulfilled: high risks are cross subsidized by the low risks and all firms make zero profits.

Figure 8. Pooling Equilibrium under a MCL

4 An Entry Game

This section presents an extension of the game above, in which the number of firms becomes endogenous. In Stage 1, a large set of potential insurers simultaneously decide whether to enter or not and the contract offered if entering. If an insurer enters he pays a fixed entry cost, denoted by $F > 0$. Thus, the set of entrants Φ becomes endogenous in this game. The rest of the game proceeds as in the standard game: individuals choose among the available contracts $\Sigma = \{S_i\}_{i \in \Phi}$ in Stage 2.

Definition 2. *In the Entry Game, the triplet $\{\Phi, \Sigma, g\}$ constitutes an Entry Game Competitive Nash Equilibrium (ENE) if $\{\Sigma, g\}$ is a CNE for Φ, no firm $k \in \Phi$ makes losses, and no firm outside Φ obtains positive profits by offering a contract S' (that might not be in Σ).*

Unfortunately, it can be shown that no ENE exists under laissez faire. Interestingly, the MCL can overturn this non-existence result. In fact we have already seen an example. Recall that in Figure 7 we depicted the equilibrium contract pair (H^{1a}, L^{2a}), where minimum coverage ensures the same (variable) profits $\Pi > 0$ for all firms, and exactly two firms offer contract L^{2a}. If fixed cost is exactly equal to Π we have an ENE. We now provide a more complete characterization of such equilibria.

For a given fixed entry cost F, the contract aimed at the high risk offers full coverage at a premium that ensures that the only insurer offering it, Firm 1, recovers F. Denote the indifference curve by $V^H(H^1)$. The $M - 1 \geq 2$ other firms, say firms $2 - i$ with $i = 1, ..., M$; attract all the low risks with a contract L^{2-i} satisfying the binding high-risk incentive compatibility constraint, and coverage exactly satisfying the regulation. The actual number of firms offering that can be sustained in equilibrium and the total profits each firm makes, which need not be zero, depends on how strict the minium coverage regulation is.

Figure 9 illustrates the candidate for several positions of the minimum coverage c^*. The origins of the isoprofits for firms $2-i, i = 1, ..., M$ are given in the Lemma 1.

Figure 9: The Entry game

Given the contract H^1 and a minimum coverage c^* between c_1^* (included) and c_2^* (excluded), one firm finds profitable to specialize in low-risks. Denote by x the intersection between the minimum coverage line and the indifference curve $V^H(H^1)$. Obviously, x is in segment $L^1 - L^2$

and is an incentive compatible contract intended for low-risks. Importantly, this contract yields positive profits as long as the contract is offered by a single firm only. If more than one firm offer x, the market will yield losses to all firms specialized in low-risks.

In the initial case of $c^* \in [c_1^*, c_2^*[$, where a single firm specialized in low-risks, there are profitable deviations. Basically, for any given contract x that yields zero profits with a single firm, there is a deviation x' along $V^H(H^1)$ that is slightly to the left in segment $L^1 - L^2$ that yield positive profits. Of course, x' allows for a potential entrant to undercut and monopolize the market, ruling out the existence of separating equilibrium in this range of minimum coverage.

As minimum coverage increases, there comes a point where two firms attracting low risks fit in the market. Following the same construction, given a contract H^1 and a minimum coverage $c^* \in [c_2^*, c_3^*[$, denote by y the intersection between the minimum coverage line and the indifference curve $V^H(H^1)$. Now, the regulation generates enough profits for two firms offering contract y that falls into the segment $L^2 - L^3$. The reason is that as the minimum coverage increases, the contracts intended for low-risks start making positive profits. Since now two firms are offering contract y, if one of them tries to make additional profits it will either attract high risks or will loose all clients. This competitive effect only exists with two or more active firms specialized in low-risks. Therefore, the pair of contracts (H^1, y) are a separating Nash equilibrium.

As the minimum coverage keeps increasing, more firms could fit into the market, replicating the case above with more firms, under fixed costs and endogenous entry. However, there is high enough minimum coverage that allows for profitable pooling deviations. In this regard, notice that the parameter configuration in Figure 9 ensures that the pair (H^1, L^M) –H^1 is not depicted– is robust to pooling deviations (a monopolizing pooling contract must lie above the low risk indifference curve through any of the points in the H-risk indifference curve, which implies that they are also above the zero-isoprofit line associated to such deviation).

5 Conclusions

Using the model of Rothschild and Stiglitz (1976), we have shown that a minimum coverage legislation (MCL) may have undesirable effects on the market. Namely, rather than implementing a desired cross-subsidization among individuals, it may benefit the insurers and make all individuals worse off. This will be that case if the binding MCL is sufficiently weak. For instance, in Obamacare, the minimum coverage is determined by the so called Bronze Plan. Our results imply that, in the context of our model, if this plan is not too demanding then Obamacare could have anti-competitive effects. For sufficiently stringent MCL we recover the desired result: a pooling equilibrium with zero profits becomes the unique equilibrium of the game. In doing this, we have abstained from using non-Nash equilibrium notions and we obtain a much more precise prediction on the market structure arising once the MCL is established.

It remains for further research to build a model of entry that can satisfactorily endogenize the number of firms. We have made a small step in this direction by proposing such a game and proving existence of a competitive-Nash equilibrium with entry for some intermediate range for the minimum coverage. Alas, the nonexistence of Nash equilibria under laissez faire impedes any normative judgements on the desirability of the legislation in the entry game proposed.

References

Bunce, V., and J. Wieske (2010): "Health Insurance Mandates in the State, 2010," *Virginia: Council for Affordable Health Insurance*.

Encinosa, W., and D. Sappington (1997): "Competition among health maintenance organizations," *Journal of Economics & Management Strategy*, 6(1), 129–150.

Encinosa, W. E. (2001): "A comment on Neudeck and Podczeck's," *Journal of Health Economics*, 20(4), 667–673.

Finkelstein, A. (2004): "Minimum standards, insurance regulation and adverse selection: evidence from the Medigap market," *Journal of Public Economics*, 88(12), 2515–2547.

Keating, R. (2011): "Health Care Policy Cost Index 2011: Ranking the States According to Policies Affecting the Cost of Health Care," *Small Business and Entrepreneurship Council*.

Mahar, S., K. M. Bretthauer, and P. A. Salzarulo (2011): "Locating specialized service capacity in a multi-hospital network," *European Journal of Operational Research*, 212(3), 596–605.

McFadden, D., C. Noton, and P. Olivella (2012): "Remedies for Sick Insurance," *NBER Working Paper*, (w17938).

Morrisey, M. A. (2001): "Competition in hospital and health insurance markets: a review and research agenda.," *Health Services Research*, 36(1 Pt 2), 191.

Neudeck, W., and K. Podczeck (1996): "Adverse selection and regulation in health insurance markets," *Journal of Health Economics*, 15(4), 387–408.

Olivella, P., and M. Vera-Hernandez (2010): "How complex are the contracts offered by health plans?," *SERIEs: Journal of the Spanish Economic Association*, 1(3), 305–323.

Pauly, M. (2012): "Wussinomics: the state of competitive efficiency

in private health insurance," *International Journal of Health Care Finance and Economics*, pp. 1–11.
Rothschild, M., and J. Stiglitz (1976): "Equilibrium in competitive insurance markets: An essay on the economics of imperfect information," *Quarterly Journal of Economics*, 90(4), 629–649.
Schneider, J. E., T. R. Miller, R. L. Ohsfeldt, M. A. Morrisey, B. A. Zelner, and P. Li (2008): "The economics of specialty hospitals," *Medical Care Research and Review*, 65(5), 531–553.
Tiwari, V., and H. S. Heese (2009): "Specialization and competition in healthcare delivery networks," *Health care management science*, 12(3), 306–324.
Vanberkel, P. T., R. J. Boucherie, E. W. Hans, J. L. Hurink, and N. Litvak (2012): "Efficiency Evaluation for pooling resources in Health care," *OR spectrum*, pp. 1–20.
Villeneuve, B. (2003): "Concurrence et antisélection multidimensionnelle en assurance," *Annales d'Économie et de Statistique*, pp. 119–142.

APPENDICES

Appendix 1: Change of Variable

Recall that if an individual has purchased a contract $(\widetilde{P}, c)$, his potential wealth outcomes are $s = w - \ell - \widetilde{P} + c$ if sick, and $n = w - \widetilde{P}$ if healthy. Notice that these two equations are independent of type. It is easy to check that these two equations can be expressed as $\widetilde{P} = w - n$ and $c = s - n + \ell$. Denote by p_J the risk probability of group $J \in \{H, L\}$ and by $\bar{p} = \lambda p_L + (1-\lambda)p_H$, the risk probability of the entire population.

An insurer attracting a J-risk with contract $\left(\widetilde{P}, c\right)$ expects to obtain

$$\Pi_J(\widetilde{P}, c) = \widetilde{P} - p_J c. \tag{6}$$

Using the previous expression for c and $\widetilde{P}$ we can say that the insurer attracting a J-risk with a contract (n, s) expects to obtain

$$\Pi_J(n, s) = w - n - p_J\left(s - n + \ell\right). \tag{7}$$

An insurer attracting a mix of both risks expects to obtain

$$\begin{aligned}\Pi_I(\widetilde{P}, c) &= \lambda\left(\widetilde{P} - p_L c\right) + (1-\lambda)\left(\widetilde{P} - p_H c\right) && (8)\\ &= \widetilde{P} - \left(\gamma p_L + (1-\lambda)\, p_H\right) c && (9)\\ &= \widetilde{P} - \bar{p}c. && (10)\end{aligned}$$

Again using the expressions of c and $\widetilde{P}$, can rewrite this as

$$\Pi_J(n,s) = w - n - \bar{p}\,(s - n + \ell)\,.$$

Appendix 2: Proofs of all Lemmata and Propositions

Proof of Lemma 1

Proof. *Step 1 Change of variable given a contract* $\left(\widetilde{P}, c\right)$. Recall that $s = w - \widetilde{P} - \ell + c$ and that $n = w - \widetilde{P}$. Solving these two equations for $\widetilde{P}$ and c yields

$$\widetilde{P} = w - n \tag{11}$$

and

$$c = s - n + \ell. \tag{12}$$

Step 2. Isoprofits associated to $\Pi > 0$

Take a single firm attracting all individuals of type H with contract $\left(\widetilde{P}, c\right)$. The isoprofit is given by $N\,(1-\lambda)\left(\widetilde{P} - p_H c\right) = \Pi$. By using $\alpha = \Pi/N$, (11) and (12), we can rewrite the expression as the explicit formula

$$s = \frac{w - n\,(1 - p_H) - p_H \ell - \frac{\alpha}{1-\lambda}}{p_H}. \tag{13}$$

Notice that the slope is $\frac{1-p_H}{p_H}$.[18] As for the position of the no-coverage point, we let $c = 0$, or using the change of variable, $s - n + \ell = 0$, or

$$n = s + \ell \tag{14}$$

Substitute into (13) yields

$$s = \frac{w - (s + \ell)\,(1 - p_H) - p_H \ell - \frac{\alpha}{1-\lambda}}{p_H}, \tag{15}$$

or

$$s = w - \ell - \frac{\alpha}{1-\lambda}$$

Replacing into (14) yields

$$n = w - \frac{\alpha}{1-\lambda}$$

[18] Notice that the zero profit does not go through the endowment point A: for a fixed cost $F > 0$ and $n = w$ (no insurance and no accident) implies $a = w - \frac{F}{(1-\lambda)N\pi_H} - \ell$, a lower point than $w - \ell$, the final wealth when accident. How low depends on $\frac{F}{(1-\lambda)N\pi_H}$, i.e., on all parameters except the loss.

Take now a single firm attracting all individuals of type L with contract $\left(\widetilde{P}, c\right)$. Then use (13) substituting $1-\lambda$ by λ and p_H by p_L:

$$s = \frac{w - n\left(1 - p_L\right) - p_L \ell - \frac{\alpha}{\lambda}}{p_L}$$

Notice that the slope is again $\left(1 - p_L\right)/p_L$. As for the position of the No-coverage point: $c = 0$, we get $n = w - \frac{\alpha}{\lambda}$ and $s = w - \ell - \frac{\alpha}{\lambda}$. (Notice that if $\lambda = 1 - \lambda = 1/2$ then the no-coverage locus coincide across types. This is used in the figures.)
Take a single firm attracting all individuals with (pooling) contract $\left(\widetilde{P}, c\right)$. Using a similar argument as above, and letting $\bar{p} = \lambda p_L + \left(1 - \lambda\right) p_H$, the isoprofit line becomes

$$s = \frac{w - n\left(1 - \bar{p}\right) - \ell \bar{p} - \alpha}{\bar{p}},$$

where we have again used (13) substituting λ by 1 and p_L by $\bar{p}$. Slope is $\frac{1-\bar{p}}{\bar{p}}$. At zero coverage, the point is given by $n = w - \alpha$ and $s = w - \ell - \alpha$.
Finally, take an m-poly attracting low risks. The isoprofit becomes $\frac{N}{m}\lambda\left(\widetilde{P} - p_L c\right) = \Pi$. Use $\alpha = \Pi/N$, (11) and (12) to get

$$s = \frac{w - n\left(1 - p_L\right) - \ell p_L - \frac{\alpha m}{\lambda}}{p_L}.$$

Slope is once more $\left(1 - p_L\right)/p_L$. No coverage point becomes $n = w - \frac{\alpha m}{\lambda}$, $s = w - \ell - \frac{\alpha m}{\lambda}$.
We compare the status quo point $n = w$, $s = w - \ell$ with each of these no-coverage/$\Pi-$isoprofit points to obtain the proposition. ■

Proof of Lemma 2

Proof. We use Figure A1 to illustrate this result.
Part (i) Take a inefficient contract like h in Figure A1. Any insurer offering h can deviate to contract h' that covers more and costs more but leaves the high risks indifferent, so that IC is preserved. Contract h' yields more profits.
Part (ii). The contract aimed to low risks should not be preferred to H by the high risks and also should satisfy the MCL. Therefore, it must lie on or above the minimum coverage line as well as on or above the indifference curve $V^H(H)$. Consider first contract x in Figure A1,

which is neither in curve $V^H(H)$ nor in the minimum coverage line. A small deviation in the direction towards the crossing L (as indicated by the arrow) will yield almost the same, albeit lower, profits but it will monopolize all low risks and attract no high risks. If x was exactly on either $V^H(H)$ or the minimum coverage line but not in L, a small approach towards L will be a profitable deviation for the same reasons.
Part (iii). Suppose by contradiction that a single firm offers L. This firm could raise premium while maintaining the same coverage. This would be legal and preserve separation (since the incentive compatibility constraint for the low risks is slack and the high risks' one is reinforced) while profits would increase.
Parts (iv) and (v). If no firm was offering H then L would become a pooling contract. Let us now prove that no more than one firm can be offering and that $\Pi^H \leq \Pi_i^L$.
Suppose first that $\Pi^H > 0$. Suppose by contradiction that two firms were offering H. Then one of them could gain by undercutting the other, that is, by offering a contract slightly cheaper than H. This would preserve separation (again, the incentive compatibility constraint for the low risks is slack and the high risks' one is reinforced) and profits would be almost doubled. Suppose by contradiction that $0 \leq \Pi^L < \Pi^H$ and at least two firms offer L. Then one of these firms gains by undercutting Firm 1, that is, by offering a contract H' that offers the same coverage as H at a slightly lower premium, so that it obtains $\Pi^H - \varepsilon > \Pi^L$. Separation is preserved in this undercutting since the IC of the low risks is slack.
Suppose now that $\Pi^H = 0$. It is obvious that $\Pi^L < 0 = \Pi^H$ cannot be part of an equilibrium (just let one of the firms offering L deviate to an arbitrarily expensive premium). Hence $\Pi^L \geq \Pi^H = 0$. Suppose that more than one firm offers H. Then one of these firms would gain by offering instead contract L. This would preserve separation and yet this firm would now make positive profits. ■

Figure A1. Lemma 2

Appendix 3: Minimum *Net* Coverage Legislation

This section shows that the main results are robust to consider the alternative regulation that sets a fixed wealth when sick. Formally, suppose regulation sets a fixed wealth when sick, that is, $s = s^*$. Then we can write $s = w - \ell + c - P = s^*$. Since w and ℓ are exogenous, this defines a one-to-one relationship between premium and coverage given by $c = s^* + P + \ell - w$. If an insurer raises P by x dollars, then the coverage must be raised by the same amount. Graphically, this implies the combination of two shifts: a downward South West shift that reflects the increase in premium affecting *both* states of nature; and an upward shift reflecting the increase in coverage that only takes place in the sick state. Since individual's final wealth when healthy is $n = w - P$, the previous finding implies $n = w - (w - \ell + c - s^*) = \ell - c + s^*$, that is consistent with horizontal changes in the final wealth space, as depicted in Figure A2. We refer to the horizontal locus associated to $s = s^*$ as "the minimum net coverage line at s^*" (MNCL).[19]

Figure A2: Net Coverage Regions for a Given s*

The possibility to sustain equilibria where *all* firms obtain positive profits also holds under this regulation. In short, the same line of arguments apply. Let us start by showing in Figure A3 that the equilibrium suggested by NP, where only firms attracting low risks make positive profits, can also be sustained as a CNE. The equilibrium set of contracts is (H_{np}, L_{np}). Notice that a firm offering contract H_{np} attracts high risks only at zero profits. Firms offering L_{np} only attract low risks and make some positive profits per insuree. Only a single firm can be offering H_{np}, however, given two firms one of them would have a gain by offering L_{np} instead. The rest of firms offer contract L_{np}. There are no constraints on how many firms are in the market to sustain this equilibrium. However, to rule out pooling deviations we require (as usual) that the proportion of low risks be small enough. This is ensured in Figure A3.

Let us now show that, as under the same MNCL legislation, other equilibria exist. Take the contract pair (H_{oo}, L_{oo}) in Figure A3. Suppose a single firm, say Firm 1, is offering contract H_{oo} and the rest of firms offer contract L_{oo}. This is an CNE pair of contracts as long as the total profits at each of the firms offering L_{oo} is at least as large as the profits obtained by Firm 1. This implies that the total number of firms in the market cannot be too large, as the per-firm profits at L_{oo} would become too small. In that case one of these firms would deviate by undercutting Firm 1, that is, by offering a contract slightly cheaper than H_{oo} instead. Notice that the restriction on the proportion of low risks is more stringent than when sustaining NP's CNE.

Figure A3: Sustaining an equilibrium with positive profits everywhere with MNCL.

[19] We thank Mathias Kiffman for this suggestion.

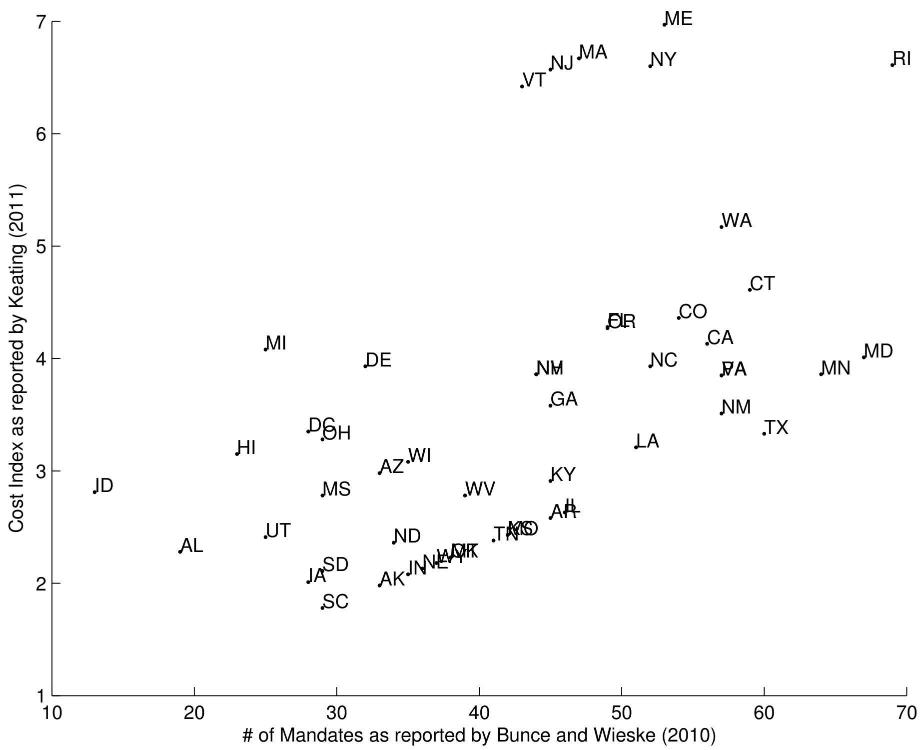

Figure 1: Mandates and Cost Heterogeneity across States in the US

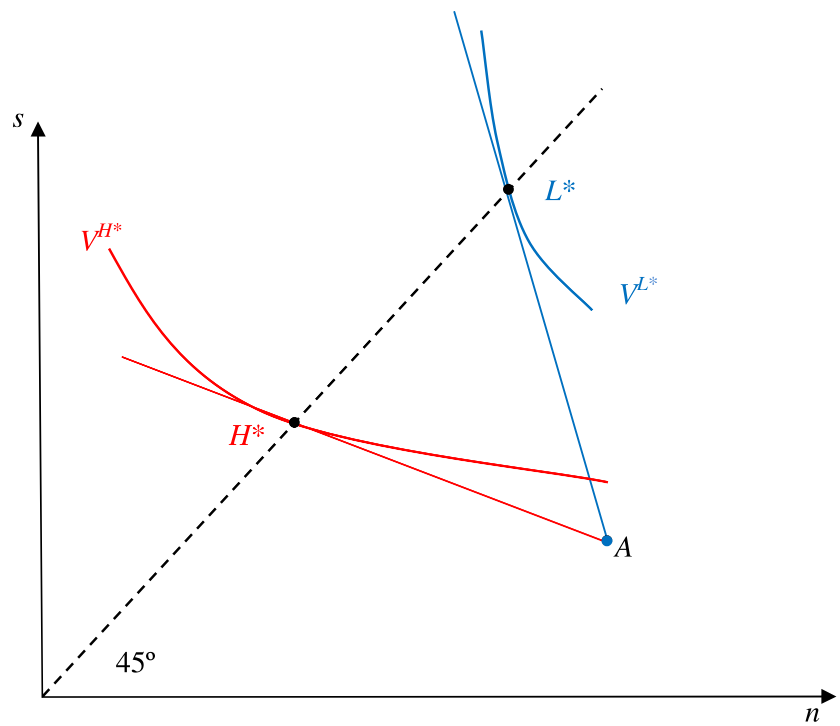

Figure 2: The Equilibrium under Symmetric Information

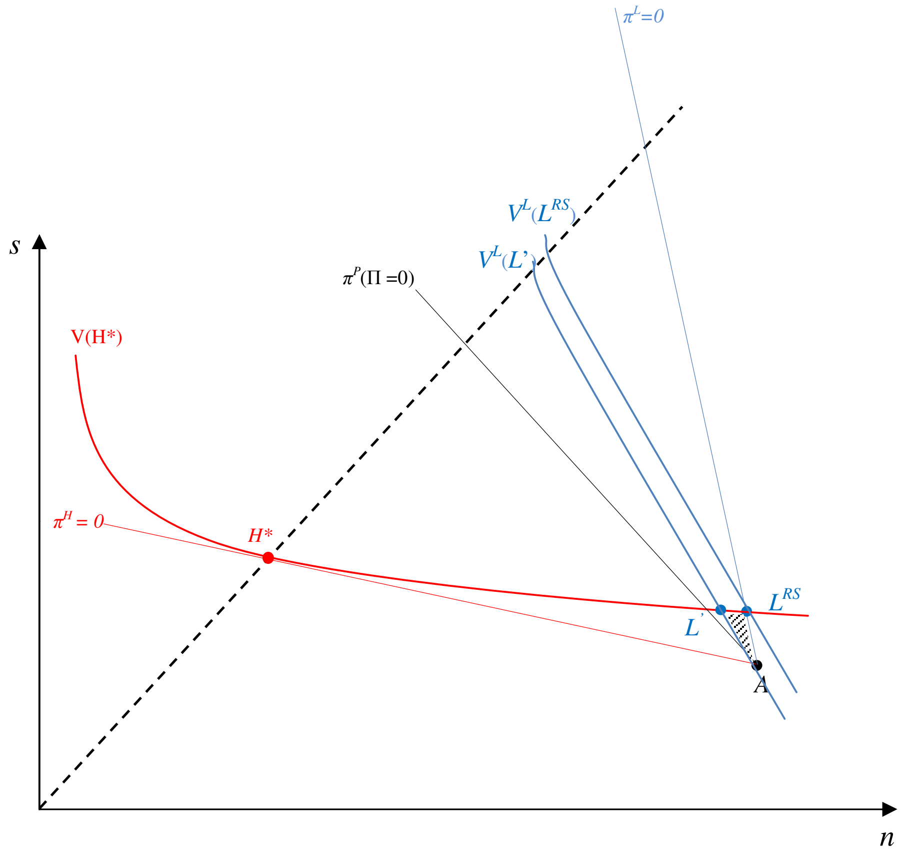

Figure 3: The Equilibrium under Asymmetric Information

Notes: In Definition 1 we characterize a Competitive Nash Equilibrium (CNE). CNE contracts are {H^*, L^{RS}}. The candidate {H^*, L'} is not an equilibrium even if only Firm 1 offers H^* and only 2 firms offer L'. One of the latter gains by deviating to the shaded area.

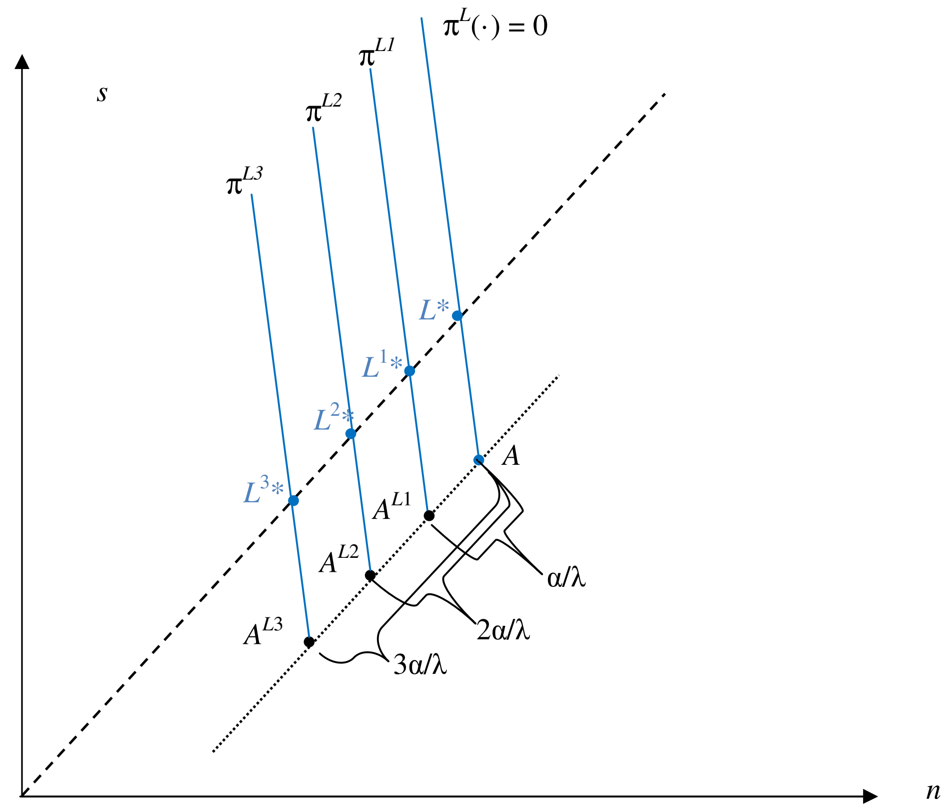

Figure 4: Isoprofit lines associated to a fixed positive profit by a contract attracting only *L*-risks, offered by $M = 1, 2, and\ 3$ firms.

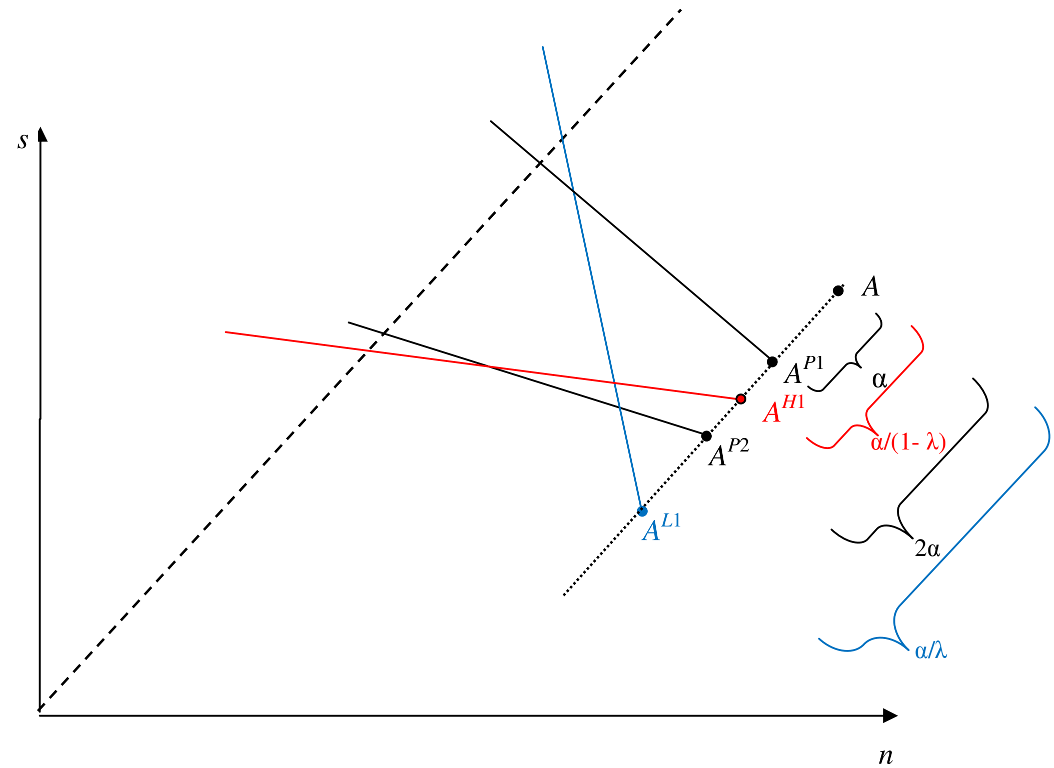

Figure 5: Isoprofit lines associated to a fixed positive profit under various mix of risk and number of firms (λ = *1/3*)

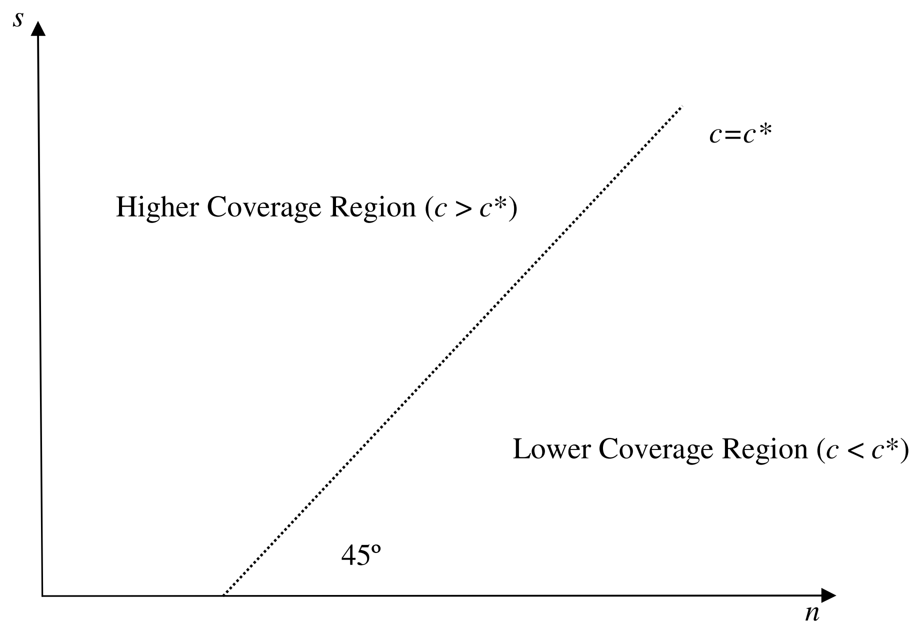

Figure 6: Coverage Regions for a given MCL c^*.

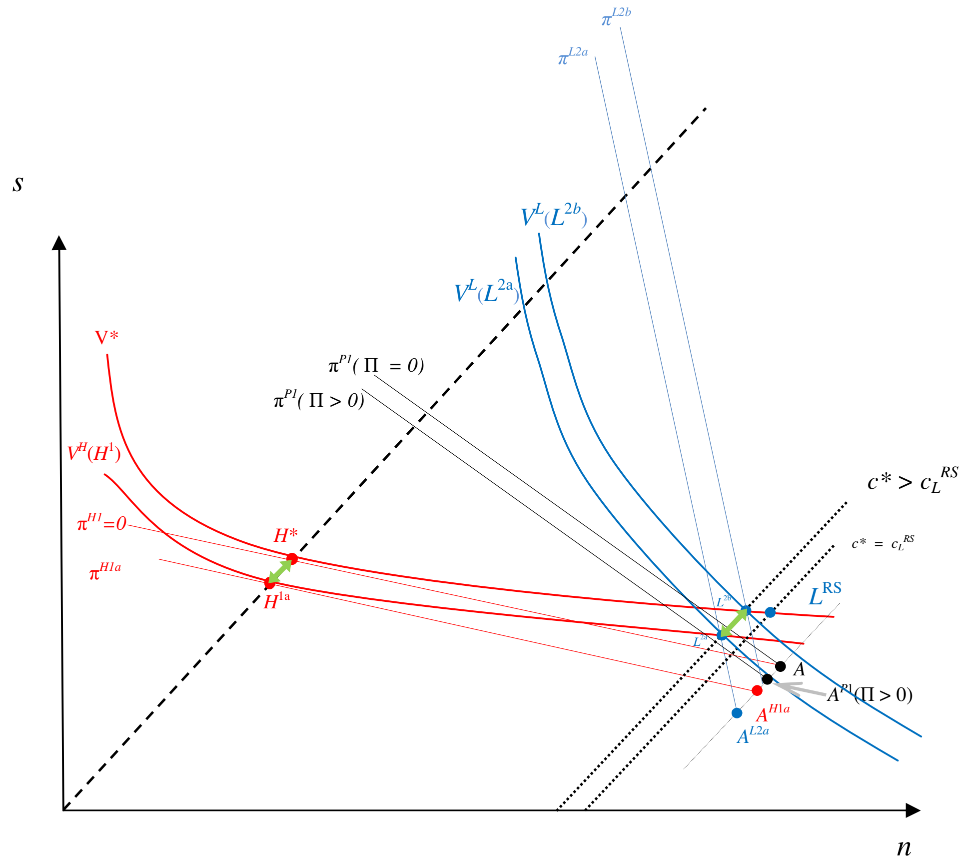

Figure 7: The CNE under Minimum Coverage Legislation

Notes: The double arrows denote the continuum of pairs that are candidates for a separating equilibrium.

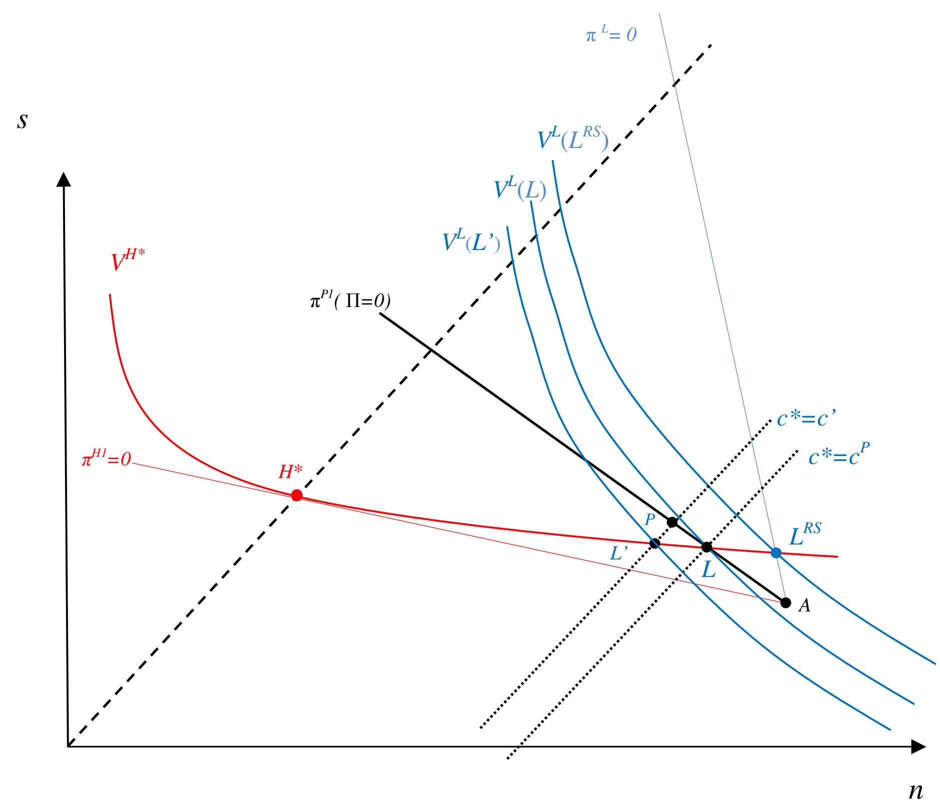

Figure 8: The Pooling Equilibrium under Minimum Coverage Legislation

Notes: For a MCL at $c^* = c^P$ there exist two equilibria: one is given by the separating pair of contracts $\{H^*, L\}$, the other by pooling contract $\{L\}$. For a MCL at $c^* = c' > c^P$, the only equilibrium is given by pooling contract $\{P\}$, since the only separating candidate $\{H^*, L'\}$ is not robust to a pooling deviation by Firm 1 in the interior of the segment PL'.

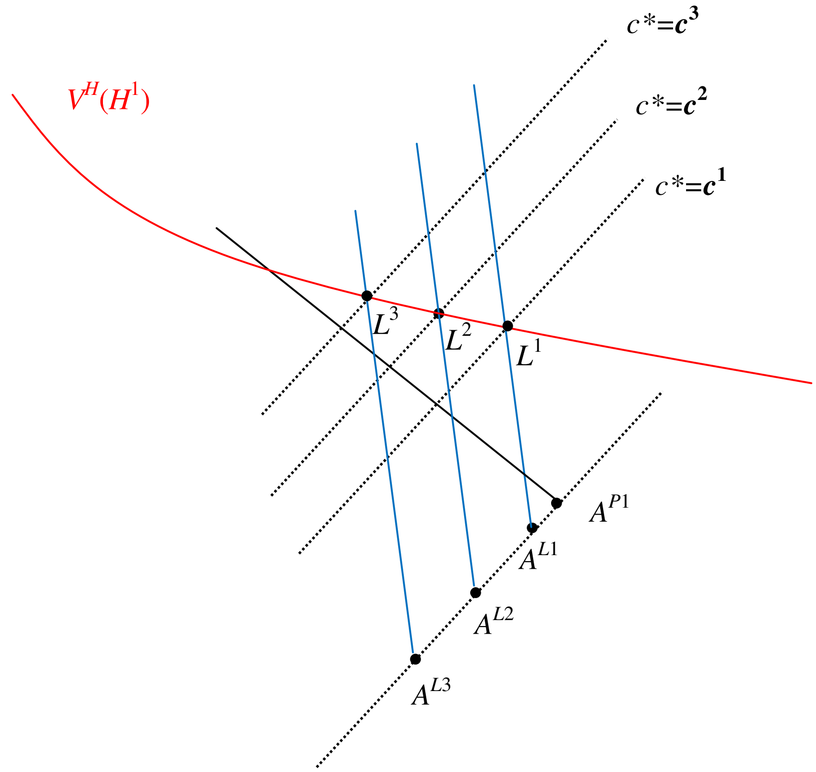

Figure 9: The Entry Game

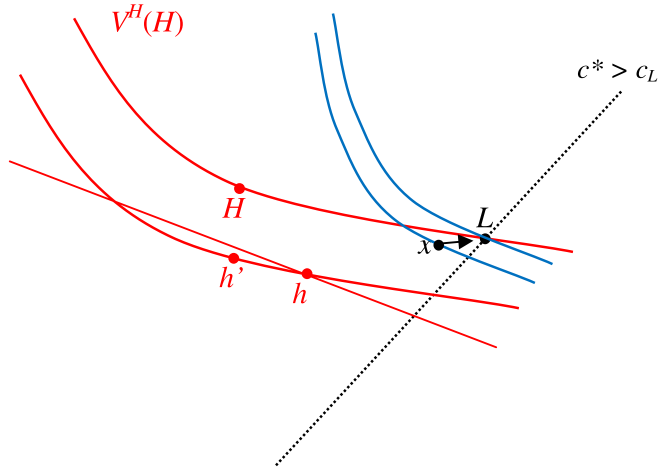

Figure A1: Lemma 2

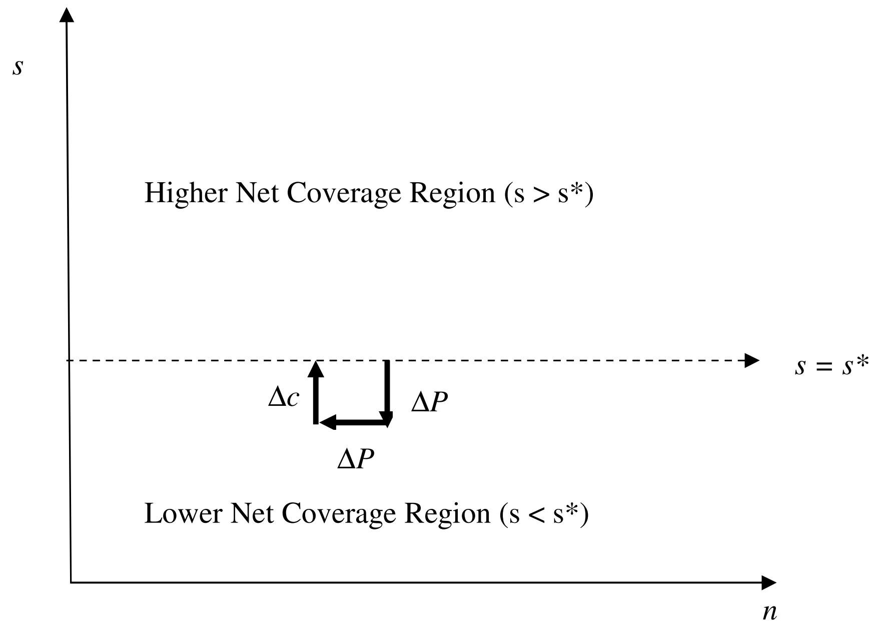

Figure A2: Net Coverage Regions for a given MNCL s*

Notes: To preserve a given level of wealth when sick s* after a premium increase Δ*P* requires an equal increase in coverage Δ*c*.

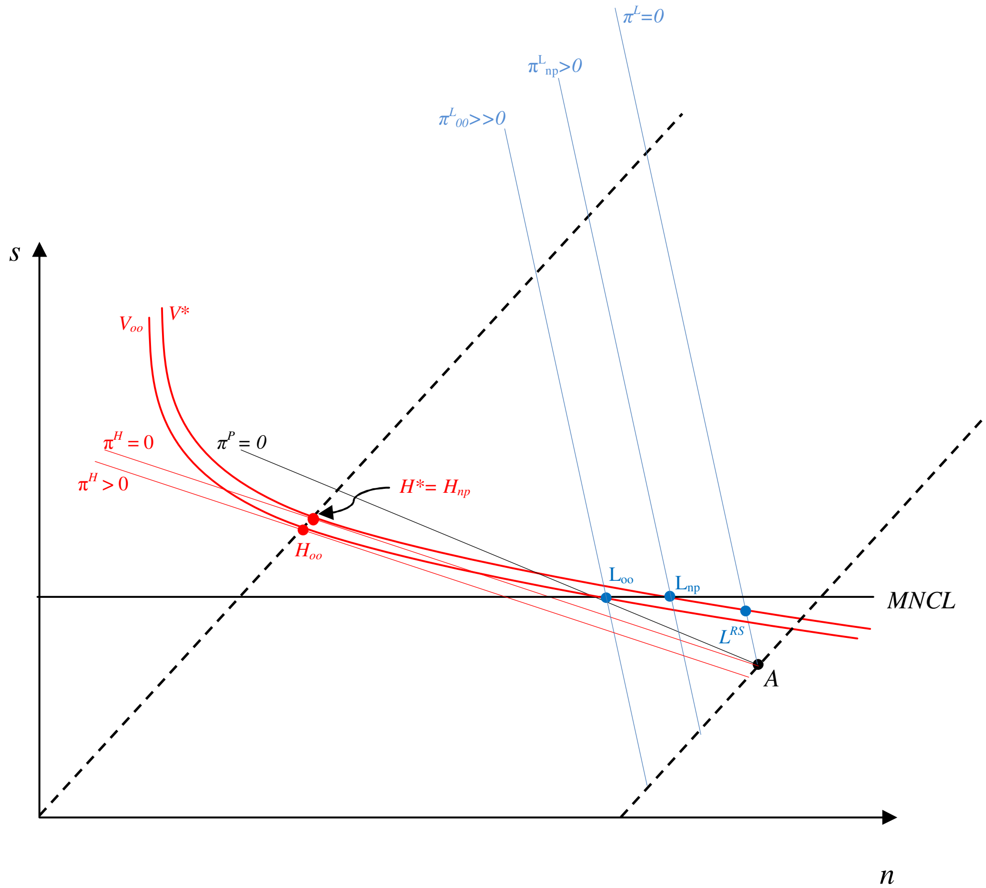

Figure A3. Sustaining equilibrium with positive profits under MNCL

Notes. (H_{oo}, L_{oo}) is an equilibrium set of contracts as long as (i) only Firm 1 offers H_{oo}; (ii) a number of firms $M_L > 2$ offer contract L_{oo}; (iii) M_L is small enough that each firm offering L_{oo} shares a fraction of total industry profits at L_{oo}, which is at least as large as the profits obtained by Firm 1.