Willingness to pay versus price of market: demand for prescription drugs and Insurance.

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Abstract

This paper contributes to the current debate on health system reform by assessing the impact of insurance market organization on the price of prescription drugs. In contrast to the classic model à la Rothschild/Stiglitz (1976), a difference exists between the monetary evaluation of the discomfort caused by the illness and the price of medication. We focus on both the adverse effects on access to drugs and the structure of the health insurance system: compulsory versus voluntary, and private versus public. While the prescription drug is always consumed when its price is inferior or equal to the discomfort, only the presence of an insurance market allows its consumption at a higher price. In addition, whatever the market type, the distortion (the difference between the drug price and the perception of price) is greater under a compulsory scheme than under a voluntary scheme. Moreover, we show that with imperfect information the distortion is always higher for the high-risk type than for the low-risk, whereas under a private regime with full information this ranking is reversed. A surprising result is that the distinction between damage and repairs induces potential non-participation of one type despite competition.

Under both perfect and imperfect information, the compulsory scheme Pareto-dominates the voluntary scheme in the private regime whereas this no longer holds in the public regime.

1 Introduction

The relationship between access to drugs and the form of the insurance system is at the heart of the current debate on the reform of health insurance. On the one hand, because it may be seen as socially optimal that certain populations have access to health care (the poorest, the oldest, or indeed everyone without distinction). However, according to the individual's insurance cover of the individual, this can encourage the over-consumption of medication. The extreme case is that the individual consumes without respect to price, in other terms, as if her willingness to pay for the drug is infinite. However, the drug market is very dynamic market in terms of innovation, and drug price is often strongly correlated with its level of innovation, and the mean price of medication has been growing. As a consequence, the greater the health insurance coverage, the greater the part of drug expenditure in health expenditure. It is therefore of primary importance to analyse the existing relation between willingness to pay for the drug and the form of the health insurance system. In the literature, a number of papers (Hall, Lippman and McCall, 1979; Dionne, 1984), have considered this issue through the role of insurance coverage on the consumer's search behavior. Here, we do not take this search behavior into account. We propose a distinction between the monetary evaluation of discomfort and the drug price.

We consider an environment with asymmetric information. The type of the individual is not public information, and for the sake of simplicity we consider only two types. The original model of Rothschild

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and Stiglitz (1976) and the related literature do not allow us to model individuals who do not participate in the competitive insurance market. However, this non-participation phenomenon does occur when health insurance is not compulsory. Contrary to the traditional Rothschild/Stiglitz model, where the amount of the individual suffering is the same as the amount paid out, we distinguish the amount of the suffering (the monetary evaluation of the discomfort caused by the disease) and the amount paid out (the price of the drug). This distinction makes clear that there are two trade-offs: to choose an insurance contract or not, and in the event of suffering whether or not to treat the suffering whatever the choice made on the insurance market. As a direct consequence, the probability of consuming the drug may differ from the probability of suffering, even in a competitive insurance market. This type of model, which has not been analysed before to our knowledge, allows us to understand why drug may be bought at a price higher than the monetary evaluation that agent has of her/his discomfort.

We show that, without insurance, the price of the drug is limited by the monetary evaluation of discomfort, while the presence of an insurance market makes it possible for there to be demand for the drug at a higher price. An insurance market induces a distortion into the drug market.

Different forms of health insurance are observed across OECD countries. In the Netherlands and Switzerland, health is based on competition between private insurers. Nevertheless, basic insurance is compulsory. In Switzerland, the size of the premium is decided by insurers themselves, who cannot discriminate between their members. In France, the compulsory part of health insurance is a monopoly. The premium is decided according to income. In the United States, individuals under 65 (apart from the poorest) subscribe to a voluntary insurance contract with a private insurer. A considerable [1] fraction of the population is uninsured. A certain part of the population are also insured *via* their firm.[2] This situation can be compared to that of a private insurer under monopoly. In this context individuals do not really have the choice of a private insurer: were they to refuse health insurance *via* the company, the premium required by any other private insurer company would be higher.

The aim of this paper is then to study the relationship between different forms of insurance and the demand for drugs at a price higher than the monetary evaluation of discomfort.

We define the concept of the individual perceived price.We show that this individual perceived price corresponds to the out-of-pocket cost when the insurance market is compulsory. The concept of the individual perceived price allows us to compute for any drug price the distortion induced by the form of the health insurance system.

In order to analyze different insurance schemes, we compare a private system (competing insurers with the possibility of discriminating between types) to a public system (a monopoly where discrimination is impossible), and a voluntary regime to a compulsory regime. We can then assess the distortion for each insurance system as the difference between 1) the price of the prescription drug, which is exogenous and 2) the individual perceived price which depends on the insurance system. The individual perceived price varies as a function of the drug price, and therefore so does the distortion. The willingness to pay is the maximum amount of money which an individual is prepared to spend on the drug. The maximal level of distorsion is reached when the prescription drug is sold at a price corresponding to the individual's willingness to pay. We show that this willingness to pay depends on the insurance system.

Without modelling the insurance market, Santerre and Vernon (2005) considered the relationship between drug demand and individual out-of-pocket costs. They do not distinguish between the concept of

[1] "Approximately 15.6 percent of the American population were without health insurance coverage in 2003, and the number of the uninsured is rising". Source: http://www.nchc.org/facts/coverage.shtml.

[2] "A third of firms in the U.S. did not offer coverage in 2003. Two-thirds of uninsured workers in 2001 worked for employers who did not offer health benefits. Even if employees are offered coverage on the job, they can't always afford their portion of the premium. Employee spending for health insurance coverage (employee's share of family coverage and deductibles) has increased 126 percent between 2000 and 2004. Losing a job, or quitting voluntarily, can mean losing affordable coverage - not only for the worker but also for their entire family)". Source: http://www.nchc.org/facts/coverage.shtml.

individual perceived price and out-of-pocket price. They find that agents' demand for drugs is inversely correlated with the individual perceived price and positively correlated with real income. In our insurance model, we imagine that everyone has the same income. We not only show that the demand for drugs is negatively correlated with the individual perceived price, but also that the individual perceived price of the drug is higher under voluntary insurance than under compulsory insurance.

We also find that the distinction between the monetary evaluation of discomfort and cost induces possible non-participation in spite of the competive insurance market. This result was previously demonstrated by Dahlby (1981) and Hansen and Keiding (2002), who compared well-being between compulsory and voluntary insurance markets in the presence of adverse selection. Nevertheless, Dahlby's model considers the level of insurance as fixed and exogenous, so that insurers choose only the amount of the premium. Hansen and Keiding (2002) assume the existence of a pooling contract in a private insurance market (Danzon, 2002). Our model has the advantage of not making these restrictive assumptions. In addition, we show that both high risks and low risks or even only one risk may be excluded from the insurance market depending on wheter information is perfect or imperfect. This result is fundamental as it provides a theoretical foundation of an empirical result which to our knowledge has not been shown in insurance models to date.

Another important result is that our model clearly reveals price distortions on the drug market, induced by the presence of an insurance market. Moreover, we show that a voluntary scheme Pareto-dominates a compulsory scheme in private regimes, whereas this is no longer the case in a public regime.

Our paper proceeds as follows. Section 2 defines the details of our two-type model relative to the classic model and discusses a first consequence: the probability of drug consumption may differ from the probability of illness. In Section 3, we set up the idea of the perception of drug price and critical price. In the two following sections, we analyse the model according to the way in which the insurance system is organized (compulsory versus voluntary). Section 4 deals with private insurance and Section 5 public insurance. In these two sections, we also analyze the effect of optimal insurance contracts (derived in the Appendices) on the perception of the drug price and the critical price, in order to calculate the distortion associated with each system on the perceived price. Section 6 summarizes and reinterprets our findings in terms of the relative power in drug price negotiation of insurers and pharmaceutical laboratories.

2 Approach and notations

2.1 Distinction between damage and repairs

In a standard model, the wealth of an uninsured agent who chooses to repair a damage is exactly the same as the wealth when he suffers his discomfort due to the damage. In other words, the monetary evaluation of the discomfort due to the damage is exactly the price fixed to repair this damage. Our approach distinguishes between this monetary evaluation of the damage called D and the price fixed to repair this damage, P while in a standard model, both concepts are confounded, and noted P. In both approaches, P and D are assumed exogenous.

So in our approach, the wealth of an uninsured agent depends on the repairs. By denoting w_0 the initial wealth identical for each individual, his wealth is $(w_0 - D)$ in case of no repair[3] and his wealth is $(w_0 - P)$ in case of repair.

If we define by *net expenses* in case of loss state (before a reimbursement) the difference between the monetary evaluation of the discomfort due to the damage and the amount of repairs, these net expenses may be positive or negative in our model, while they are zero in a standard model. This model could remind of insurance models on fraud where a gap exists between the monetary evaluation of the damage and the amount of claimed repairs. However in our model, contrary to these models, the comfort yielded by repairs is *not* different from the monetary evaluation of the damage.

[3] In this case, the agent suffers the discomfort.

An insured agent pays a premium α and is covered at the rate x. So, he receives a compensation in case of repairs after the damage, corresponding to xP in both approaches. Without loss of generality, we assume that the repairs allow to the agent to totally recover his damage D. Wealths in loss state according to our model and to the standard model correspond to:

Wealth in loss state	Standard model	Our approach
With insurance	$\begin{cases} w_0 - \alpha - P + xP \text{ if repairs} \\ w_0 - \alpha - P \text{ if no repair} \end{cases}$	$\begin{cases} w_0 - \alpha - P + xP \text{ if repairs} \\ w_0 - \alpha - D \text{ if no repair} \end{cases}$
Without insurance	$w_0 - P$	$\begin{cases} w_0 - P \text{ if repairs} \\ w_0 - D \text{ if no repair} \end{cases}$

Obviously, these differences in reservation utilities with standard model have an important effect on the demand of repairs. The relation between insurance market organization and demand of repairs is studied in details in Sections 4 and 5.

To illustrate our model and make interpretation easier, we propose to consider the context of health insurance. However, our results go way beyond the field of health economic. This model could be applied to a large number of economic fields as automobile insurance, housing insurance, life insurance or ever unemployment insurance on labour market and so on.

2.2 Probability of illness and probability of consumption

The monetary evaluation of the damage D can be here interpreted as the level of discomfort caused by an illness.The consumption of prescription drug allows for the agent to totally recover her/his health. The price of repairs P is the price of the prescription drug. Thus in the absence of insurance, the treatment of illness costs P to an agent. For the sake of simplicity, without loss of generality, we assume that the prescription drug enables agents in state of illness to recover quickly their initial health: treated agents suffer no monetary loss except the price of medication.[4]

We consider two types of agent. High risks denoted H have a higher probability p_H to have the illness than the low risks denoted L. The probability of illness of the $L - type$ is p_L.

We define by $\overline{p}$ the probability of consuming the medication in the entire population (insured or not). Its value depends on the value of $\overline{p}_i$ (for $i = H, L$) with $\overline{p}_i$ the probability of consuming medication for a type i. Thus we have $\overline{p}_L \in \{0, p_L\}$ and $\overline{p}_H \in \{0, p_H\}$, depending on the participation of each type to the insurance system.

$$\overline{p} = \frac{N_H}{N}\overline{p}_H + \frac{N_L}{N}\overline{p}_L$$

with N_i the number of type i in the population and $\sum_{i=H,L} N_i = N$ the proportion of type i in the population ($i \in \{H, L\}$).

The distinction between probability of consuming and probability of illness (damage), specific to our model, is crucial in the further analysis of the comparison between voluntary or compulsory schemes and private or public systems of health insurance.

[4]Note that a positive monetary loss relative to illness could be introduced in our model without loss of generality.

2.3 Individual preferences and isoprofit curves

We consider an environment of asymmetric information: all the individuals initially possess private information about their probability of suffering a discomfort but the individual type is not publicly observable. In the absence of insurance, the reserve expected utility of a type i is:

$$V_i(E) = p_i U(w_0 - \min\{D, P\}) + (1 - p_i)U(w_0)$$

with $E = (w_0, w_0 - \min\{P, D\})$ the point of initial endowment. E is also called the point of no-insurance. In what follows, it is necessary to distinguish $E_D = (w_0, w_0 - D)$ the point of no-insurance without treatment from $E_P = (w_0, w_0 - P)$ the point of no-insurance with purchase of the drug. By introducing $\max\{U(w_0 - P); U(w_0 - D)\}$ in the expected utility of reservation, we take into account the possibility for any agent to still purchase the medication (at the price P) in case of illness, even if he is not insured. As usual, U is a *vNM* utility function, increasing and concave in wealth.

Moreover, any individual may subscribe a contract $C = (\alpha, x)$, which specifies the premium α paid to the insurer and the gross indemnification xP received by the insured in case of illness (with $x \in [0, 1]$ the level of coverage). The expected utility for an agent i insured by a contract (α_i, x_i) is written as:

$$V_i(\alpha_i, x_i) = p_i \max\{U(w_0 - \alpha_i - P + x_i P); U(w_0 - \alpha_i - \min\{D, P\})\} + (1 - p_i)U(w_0 - \alpha_i).$$

In a voluntary system, an individual i will choose to subscribe a contract (α_i, x_i) rather than no-insurance[5] if $V_i(\alpha_i, x_i) \geq V_i(E)$. It is obvious that no rational agent would choose to subscribe a contract whose coverage would not be used in loss state.

Finally the profit earned by an insurer on a type i $(i = H, L)$ is

$$\pi_i(\alpha_i, x_i) = N_i(\alpha_i - \overline{p}_i x_i P).$$

Here the possibility for an agent i not to purchase the medication is captured by $\overline{p}_i$ the probability of consuming, which may differ from p_i the probability of illness.

3 Perception of the drug price and critical price

The presence of an insurance system could play a considerable role on the prescription drug market. Indeed, the participation of an agent to the insurance market would "distort" his perception of the drug price. The notion of perception of price is set up after the premium is paid (of course, for an uninsured agent, the premium is null). This individual perception does depend on the participation of the $i - type$. For a given price of the prescription drug P, the perception of the drug price is noted Pe_i.

Definition of the agent's perception:

The insured and consuming expected utility of an agent i is defined for any value of (x_i, α_i). To a wealth in state health is associated the corresponding level of wealth in state of illness. When the wealth in state health is equal to the inital wealth, the perceived drug price is defined by the difference between the initial wealth and the corresponding level of this wealth in state of illness.

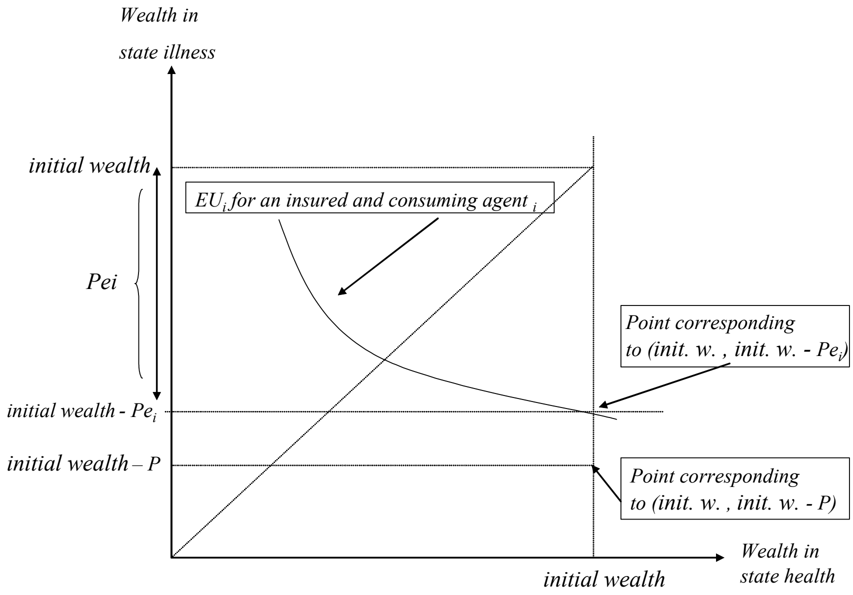
Algebrically,

$$p_i U(\text{initial wealth} - Pe_i) + (1 - p_i)\, U(\text{initial wealth}) = EU_i \text{ of an insured and consuming agent } i$$

$$\text{with, initial wealth=}\begin{cases} w_0 \text{ in voluntary scheme} \\ w_0 - \alpha_i \text{ in compulsory scheme} \end{cases} \quad \forall i = H, L$$

Graphically,

[5] Note that $V_i(E)$ is nothing else that $V_i(0, 0)$.



Note: init. w. for initial wealth

Figure 0

This notion is defined more formally for each insurance regime.

This individual perception of the drug price leads to an individual distortion of the drug price. So, the individual distortion due to the insurance market depends on the participation of the $i - type$. This distortion d_i can be measured by the difference between the drug price and the perception i.e.

$$d_i = P - Pe_i \quad \text{with} \quad Pe_i \in \{Pe_L, Pe_H\}$$

De facto, for an uninsured agent, the perception of the drug price corresponds to the drug price P.

$$Pe_i(P) = P \quad \text{for } i = H, L \tag{1}$$

Therefore, his distortion is trivially zero.

Critical prices are noted P^{C_i} with $i = H, L$ and are also called the willingness to pay of the agent. They are defined as the maximal price that an agent accepts to spend for the drug i.e. the price beyond which the agent refuses to consume. The agent accepts to consume until her/his perception of the price is equal to the monetary evaluation of her/his discomfort. Therefore, her/his willingness to pay P^{c_i} is defined by

$$Pe_i(P^{C_i}) = D \quad \text{for } i = H, L \tag{2}$$

We can easily determine the critical price for an uninsured agent i. Indeed, from equations (1) and (2), we have

$$P^{C_i} = D$$

Notice that this result can be found by another way. Indeed, the uninsured agent accepts to spend for the drug whenever his utility in case of treatment is higher than his utility in the absence of treatment in state loss[6] i.e. whenever,

$$\underbrace{U(w_0 - P)}_{\text{Utility if no insurance and treatment}} \qquad \geq \qquad \underbrace{U(w_0 - D)}_{\text{Utility if no insurance and no treatment}}$$

[6] We assume that, conditionally to the state illness, if a type i is indifferent between treatment and no treatment, she/he consumes the drug.

Therefore, we also find that the uninsured agent consumed while $P \leq D$. Thus, for an uninsured agent, the critical price is equal to his discomfort D, i.e. $P^{C_i} = D$.

It is trivial to show that for $P \leq D$, there is a demand of prescription drug for any value of P. That does not depend on the insurance market. On the contrary, when $P > D$ the consumption of the medication depends on the insurance system. Only insured agents can consume the drug. Any consumption of medication will be due to the presence of insurance market that will create an imperfection on the market by allowing the sell of drug to a level of price higher than D.

Graphically (Figures 1 to 6), w_{FH} and w_{FL} represent ordinates of the intersection between the indifference curve of an insured agent and the vertical line intersecting with E_P and E_D in voluntary case and with E'_P and E'_D in compulsory case (points of initial endowment net of the compulsory premium). These ordinates correspond to,

$$w_{Fi} = \begin{cases} w_0 - Pe_i \text{ in voluntary scheme} \\ w_0 - \alpha_i - Pe_i \text{ in compulsory scheme} \end{cases} \quad \forall i = H, L$$

So, graphically, the possible distortion due to the insurance market is measured by the difference between w_{FH} (respectively, w_{FL}) and $(w_0 - P)$ in voluntary scheme or $(w_0 - \alpha_i - P)$ in compulsory scheme.

The demand is depending on the probability to use drugs of each type H and L. Since these probabilities are themselves depending on whether the insurance is compulsory or voluntary and the market is public or private, we study the demand of drugs associated to the four regimes. The analytic resolution of each program is presented in Appendices.

4 Private insurance

In case of a private insurance, we consider a competitive insurance market. Given the absence of regulation, insurers discriminate between high risks and low risks by offering separate contracts with different premia α_i and levels of coverage x_i. We compare the case of compulsory insurance with the one of voluntary insurance, first in full information and second in imperfect information. For each case, we present individual perceptions of the drug price and study impacts of the insurance market on these perceptions.

4.1 Compulsory scheme

In the case of compulsory insurance system, agents have to participate to the insurance market. All agents pay the premium α_i even if they choose not to consume the drug. However, it is possible that the contract offered is a null contract. If one of the two separating contracts is a null contract, the other contract is a null one too. This is due to the compulsory aspect of the insurance system.[7] Different examples can be found in the insurance world, for instance, the French clause of compulsory insurance for the automobile insurance or the housing insurance.

4.1.1 Benchmark case: perfect information

In symmetric information, the insurer distinguishes the low risk from the high risk. If P is inferior to the critical price of each type P^{C_i}, the insurer is able to propose a contract with full-reimbursement against an actuarial premium for each type, since in this context high risks are not able to pretend to be low risks.

[7] Implicitly, it means that if we constraint a type to participate to the insurance system, we constraint both types to participate.

In other words, given that each type i always pays the premium α_i, competitive contracts in full information are derived from Program I,

$$\max_{\alpha_i, x_i} p_i \max\{U(w_0 - \alpha_i - P + x_i P); U(w_0 - \alpha_i - \min\{D, P\})\} + (1 - p_i) U(w_0 - \alpha_i) \qquad \text{(Program I)}$$
$$\text{subject to } N_i(\alpha_i - \overline{p}_i x_i P) \geq 0$$

for each type $i \in \{H, L\}$. Thus, insurers trivially maximize the expected welfare of each type subject to the no-negative profit constraint.

With $P \leq P^{C_i}$ $\forall i = \{H, L\}$, we have $\overline{p}_i = p_i$ i.e. each type consumes the drug and the optimal necessary conditions of Program I trivially lead to $x_i^* = 1$ and $\alpha_i^* = p_i P$ $\forall i = \{H, L\}$. In a world of full information, each type i would thus receive his full insurance contract, noted C_i^{PI}: the agent i pays an actuarial premium $\alpha_i^{PI} = p_i D$ against the promise to receive the indemnity P in case of illness (Figure 1a).

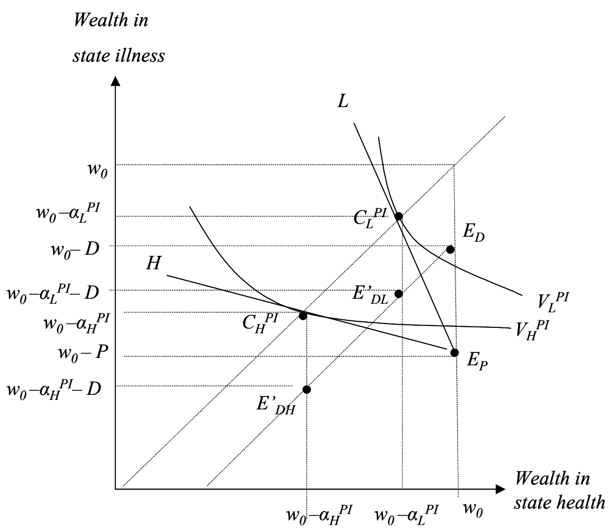


Figure 1a: Compulsory and private insurance with perfect information: $C_i^{PI;}$ always preferred to E'_{Di} by any type i

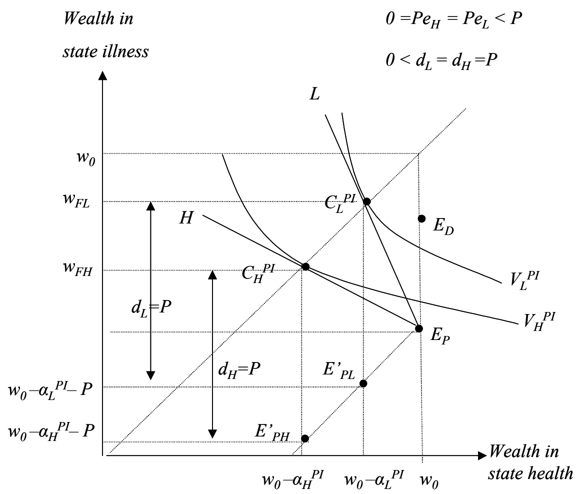


Figure 1b: Compulsory and private insurance with perfect information : Perception Pe_i and distortion d_i of the drug price

Whatever the decision about the consumption of the drug, each type has to pay the *compulsory* premium α_i^{PI}. Therefore, the initial wealth becomes $w_0 - \alpha_i^{PI}$. On one hand, an insured agent choosing to consume the medication gets a final wealth corresponding to $\left(w_0 - \alpha_i^{PI}\right)$ in both states. On the other hand, an insured agent who chooses not to consume the drug gets the final wealth in state illness $\left(w_0 - \alpha_i^{PI} - D\right)$ that is inferior to $\left(w_0 - \alpha_i^{PI}\right)$, whatever the level of the discomfort D.

Graphically (Figure 1a.): whatever D, C_i^{PI} is always preferred to E'_{D_i} by any type i, E'_{D_i} being the the allocation reached without consumption under a compulsory insurance regime.[8]

Eventually, any type submitted to the compulsory premium necessarily consumes the drug in case of illness.

From optimal contracts, individual perceptions and distortions are characterized by Lemma 1.

Lemma 1: *When information is perfect, compulsory private insurance induces a unique distortion of the price equal to P and leads to a unique willingness to pay only limited by $\frac{w_0}{\overline{p}}$.*

Proof. In a compulsory scheme, the individual i's perception of the price is defined by Pe_i such

[8] See points E'_{D_i} compared to C_i^{PI} on Figure 1a.

that:

$$p_iU(w_0 - \alpha_i^{PI} - P + x_i^{PI}P) + (1-p_i)U(w_0 - \alpha_i^{PI}) = p_iU(\underbrace{w_0 - Pe_i - \alpha_i^{PI}}_{w_{F_i}}) + (1-p_i)U(w_0 - \alpha_i^{PI})$$

$$\Leftrightarrow w_0 - \alpha_i^{PI} - P + x_i^{PI}P = w_0 - Pe_i - \alpha_i^{PI} \Leftrightarrow Pe_i = (1 - x_i^{PI})P$$

with w_{F_i}, the ordinate of the intersection between the insured i's indifference curve and the vertical line crossing E'_{P_i} (Fig.1b). For $x_i^{PI} = 1$, $Pe_i = 0$, $\forall i$. It directly follows that the individual distortion of the price is

$$d_i = P - Pe_i = w_{F_i} - (w_0 - \alpha_i^{PI} - P)$$

so the distortion d_i is maximal, equal to P.

However, the individual critical price, noted P^{C_i} and defined by $Pe_i(P^{C_i}) = D$ is

$$P^{C_i} = \frac{D}{1 - x_i^{PI}}$$

So, P^{C_i} seems to tend to infinite whatever i in a compulsory scheme. However, the critical price, or willingness to pay, is limited by the wealth of the agent. Note that the critical price of the drug is such as $w_0 - \alpha^*(P) = 0$ under the no-loan assumption. Thus the price is limited by $\frac{w_0}{\overline{p}}$.■

4.1.2 Imperfect information

Under a private regime, introducing adverse selection in the model has some "significant" effects on perception and distortion. When insurers do not observe the risk linked to the agent, high risks are now able to pretend to be low risks. The menu of actuarial contracts with full insurance holds no longer when the risk-type is not observable by insurers. We must introduce incentive constraints in Program I to derive competitive contracts in this regime. Thus, insurers maximize the expected welfare of low risks subject to the incentive constraints and the no-negative profit[9] constraints, so that optimal contracts in imperfect information are derived from Program Ib:

$$\max_{\alpha_i, x_i} p_L \max\{U(w_0 - \alpha_L - P + x_LP); U(w_0 - \alpha_L - \min\{D,P\})\} + (1-p_L)U(w_0 - \alpha_L)$$

$$\textit{subject to}$$

$$p_i \max\{U(w_0 - \alpha_i - P + x_iP); U(w_0 - \alpha_i - \min\{D,P\})\} + (1-p_i)U(w_0 - \alpha_i) \geq \quad (3)$$

$$p_i \max\{U(w_0 - \alpha_k - P + x_kP); U(w_0 - \alpha_k - \min\{D,P\})\} + (1-p_i)U(w_0 - \alpha_k) \quad i,k \in \{H,L\}, i \neq k$$

$$N_i(\alpha_i - \overline{p}_i x_i P) \geq 0 \quad \text{(Program Ib)}$$

The form of the objective function is due to imperfect information. We maximize the expected welfare of the low risks because they are the ones who support the negative externalities from high risks.

For an agent $i \in \{H,L\}$, the critical price is noted P^{C_i}. From Appendix A, we find that for $P \leq P^{C_i}$, separated contract offered to each type is the Rothschild and Stiglitz contract (Fig. 2),

$$\begin{cases} x_H^* = 1 \text{ and } \alpha_H^* = p_HP \\ x_L^* < 1 \text{ and } \alpha_L^* = x_L^* p_L P \end{cases}$$

For $P > P^{C_i}$, none is insured nor consumes the prescription drug.

[9] As usual, competition à la Rothschild/Stiglitz (1977) requires no negative profits on each contract for an equilibrium to exist. Moreover, no pooling contract is compatible with equilibrium because any situation in which some risks (here low risks) subsidize some others (high risks) would imply a possibility for a rival company to earn positive profits by attracting only low risks with a contract with a cheaper premium against the promise of a smaller coverage.

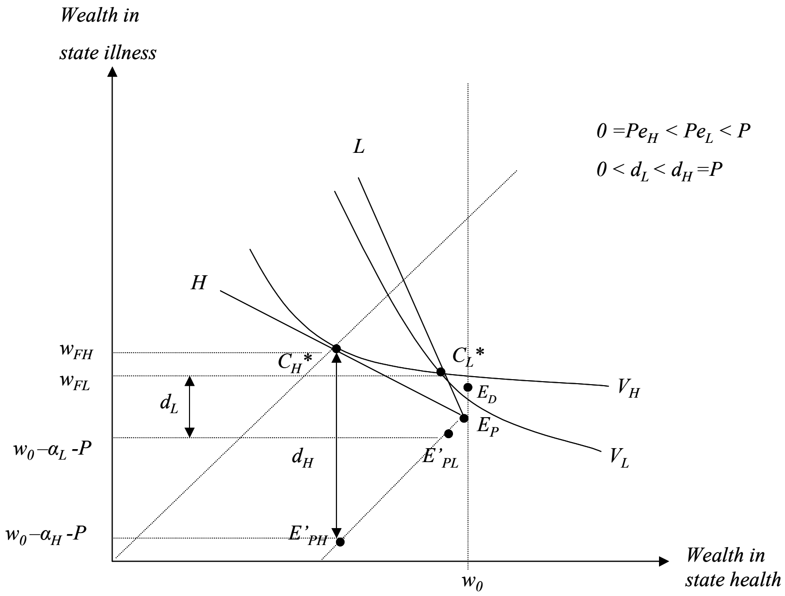


Figure 2: Compulsory and private insurance with imperfect information

Even though separate contracts lead to two different perceptions of price, the following Lemma shows that under compulsory private insurance, critical prices are identical.

Lemma 2: *Compulsory private insurance induces a distortion of the price higher for high risks ($d_H = P$) than for low risks ($d_L = x_L P$) when information is imperfect, but leads to a unique bounded willingness to pay* $P^{C_i} = P^{c_L} = \frac{D}{(1-x_L)}$.

Proof. • As explained before, the perception of the drug price is defined as the value for which the expected utility for an insured agent is equal to the expected utility if the agent is not insured but consumes the prescription drug. Here, "not insured" means that the agent does not receive any reimbursement in case of illness but, because the insurance regime is compulsory, the agent i has to pay the premium α_i. Thus, Pe_i is defined by,

$$p_i U(w_0 - \alpha_i - P + x_i P) + (1 - p_i) U(w_0 - \alpha_i) = p_i U(w_0 - \alpha_i - Pe_i) + (1 - p_i) U(w_0 - \alpha_i)$$
$$\Leftrightarrow U(w_0 - \alpha_i - P + x_i P) = U(w_0 - \alpha_i - Pe_i)$$
$$\text{and so } Pe_i(P) = P(1 - x_i)$$

So, $Pe_H(P) = 0$ and $Pe_L(P) = P(1 - x_L) < P$. Individual perception is equal to P as in perfect information for high risks while is equal to $x_L P$ for low risks (Fig. 2).

• The critical price is defined such that the perception of the drug price corresponds to the discomfort. So for low risks, P^{C_L} is defined as:

$$Pe_L\left(P^{C_L}\right) = D \Leftrightarrow P^{C_L} = \frac{D}{(1 - x_L)}$$

For high risks, the definition of P^{C_H} is *a priori* more complex. As for the low risks, the $H - type$ agents choose between either to consume or to undergo the discomfort. In addition, they may be interested by the contract intended to low risks. That implies that the incentive constraint of the $H - type$ has to be taken into account in the definition of the critical price in order to make him indifferent between his contract and the $L - type$'s contract.

It is trivial to show that $\frac{D}{(1-x_L)}$ is also the critical price for $H - risks$ i.e. the maximal amount high risks accept to spend to consume the drug. Indeed, high risks do not consume whenever,

$$p_H U(w_0 - \alpha_H - P + x_H P) + (1 - p_H)U(w_0 - \alpha_H) < p_H U(w_0 - \alpha_{_L} - D) + (1 - p_H)U(w_0 - \alpha_L) \quad (4)$$

In the right member of (4), the compulsory premium paid by $H - type$ is $\alpha_{_L}$ instead of $\alpha_{_H}$ because each type chooses to pay the lowest premium $\alpha_{_L}$ when suffering the discomfort is preferred to consuming the drug in state illness.

Given that the H' incentive constraint is binding, Inequation (4) is equivalent to

$$p_H U(w_0 - \alpha_L - P(1 - x_L)) + (1 - p_H)U(w_0 - \alpha_L) < p_H U(w_0 - \alpha_{_L} - D) + (1 - p_H)U(w_0 - \alpha_L)$$

that is always verified whenever $P > \frac{D}{(1-x_L)}$. Thus, the critical price does not depend on the coverage of $H - type$. ■

Remark that the perception of price appears to coincide with the universal notion of *out-of-pocket price* under the compulsory scheme. The condition $P < P^{C_i}$ may be interpreted in terms of out-of-pocket. Indeed, $P < \frac{D}{(1-x_L)} \Leftrightarrow P(1 - x_L) < D$ i.e. the *out-of-pocket price* is inferior to the monetary evaluation of the discomfort, D. In contrast, this holds no more longer under the voluntary scheme, in which perception may differ from out-of-pocket.

4.2 Voluntary scheme

In this system, agents are not submitted to compulsory insurance. Individuals subscribe a contract from an insurer or remain not insured. Remark that under voluntary insurance, when an agent i participates to insurance, he necessarily consumes the drug in case of illness. Moreover, when a type i chooses not to participate to insurance, he chooses also not to consume the medication. Indeed, if he would consume the drug without contract, an insurer could always offer one contract that increases his expected utility. In addition, since the market is private, the reciprocal assertion is true. In other words, participation implies consumption and reciprocally[10].

4.2.1 Benchmark case: perfect information

Voluntary insurance does not allow to do any assumption on which type(s) do(es) participate to insurance. So, we take into account the exit option of the agent. Indeed in Program II, the choice of each type i to participate to the insurance market is captured by $\max\{V_i(0,0); V_i(\alpha_i, x_i)\}$. Any consumer is thus lead to choose between the best contract offered by competitive insurers and the best "option of exit".

$$\underset{\alpha_i, x_i}{Max} \ \{max\{V_L(0,0); V_L(\alpha_L, x_L)\}\} \quad \text{(Program II)}$$
$$\text{subject to } N_i(\alpha_i - \overline{p}_i x_i P) \geq 0 \ \ i \in \{H, L\}$$

Because the contracts are separated and the insurance scheme is voluntary, three situations occur:

$$\begin{cases} \text{When both types are insured } x_i^* = 1 \text{ and } \alpha_i^* = p_i P, \ \forall i \quad \text{(Fig. 3, } E_{D1}) \\ \text{When only the low risks are insured but not the high risks, } \begin{cases} x_L^* = 1 \text{ and } \alpha_L^* = p_H P \\ x_H^* = 0 \text{ and } \alpha_H^* = 0 \end{cases} \quad \text{(Fig. 3, } E_{D2}) \\ \text{When no type is insured, } x_i^* = 0 \text{ and } \alpha_i^* = 0, \ \forall i \quad \text{(Fig. 3, } E_{D3}) \end{cases}$$

[10] Note that this implication may not hold more longer under a public voluntary regime.

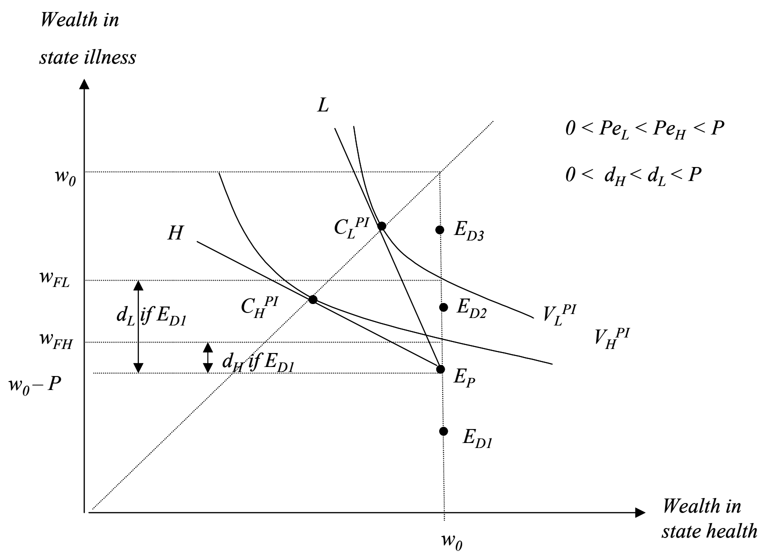


Figure 3: Voluntary and private insurance with perfect information

The individual i's perception of the price is defined by Pe_i such that:

$$p_i U(w_0 - \alpha_i^{PI} - P + x_i^{PI} P) + (1 - p_i) U(w_0 - \alpha_i^{PI}) = p_i U(\underbrace{w_0 - Pe_i}_{w_{F_i}}) + (1 - p_i) U(w_0) \tag{5}$$

Lemma 3: *Under perfect information, voluntary private insurance system induces a distortion of the price higher for $L - type$ than for $H - type$, and low risks are willing to pay more than the high risks for consuming the drug.*

Proof. When both types are insured, Eq. (5) is equivalent to,

$$U(w_0 - p_i P) = p_i U(w_0 - Pe_i) + (1 - p_i) U(w_0)$$
$$\Leftrightarrow U(w_0 - p_i P) - U(w_0) = p_i \left[U(w_0 - Pe_i) - U(w_0) \right]$$

Moreover, $p_H > p_L$ implies

$$U(w_0 - p_H P) - U(w_0) < U(w_0 - p_L P) - U(w_0)$$
$$\Rightarrow p_H \left[U(w_0 - Pe_H) - U(w_0) \right] < p_L \left[U(w_0 - Pe_L) - U(w_0) \right]$$
$$\Rightarrow U(w_0 - Pe_H) < U(w_0 - Pe_L) \Leftrightarrow Pe_H > Pe_L$$

Thus, the distortion is higher for $L - type$ than for $H - type$. The case with only one type insured is the case where only $L - type$ is insured. Therefore, her/his perception remains Pe_L while the perception of $H - type$ becomes P, so that $d_L > d_H$. With no type insured, the individual perception is P, $\forall i$.

As a direct consequence, the critical price of $L - type$ is superior to the $H - type's$ one, meaning that the high risk would be the first type to leave the insurance market in case of attractive option of exit.■

Remark that whatever the type, the distortion is higher under a compulsory scheme than under a compulsory scheme.

4.2.2 Imperfect information

Competitive contracts are derived from the maximization of the $L-type$'s welfare subject to incentive constraints and no-negative profit constraints:

$$\underset{\alpha_i,x_i}{Max}\ \{max\{V_L(0,0);V_L(\alpha_L,x_L)\}\} \qquad \text{(Program IIb)}$$

$$\text{subject to}$$

$$max\{V_i(0,0);V_i(\alpha_i,x_i)\} \geq max\{V_i(0,0);V_i(\alpha_k,x_k)\} \quad i,k \in \{H,L\}, i \neq k$$

$$N_i(\alpha_i - \overline{p}_i x_i P) \geq 0 \quad i \in \{H,L\}$$

Because the contracts are separated and the insurance scheme is *voluntary*, the participation to the insurance market of one type does not depend on the participation of the other type (as opposite to the compulsory case). So, four subcases are analyzed in Appendix B on the participation of each type i. From Appendix B, we obtain

$$\begin{cases} \text{When both types are insured} \begin{cases} x_H^* = 1 \text{ and } \alpha_H^* = p_H P \\ x_L^* < 1 \text{ and } \alpha_L^* = x_L^* p_L P \end{cases} \\ \\ \text{When only the high risks are insured but not the low risks,} \begin{cases} x_H^* = 1 \text{ and } \alpha_H^* = p_H P \\ x_L^* = 0 \text{ and } \alpha_L^* = 0 \end{cases} \\ \\ \text{When no type is insured, } x_i^* = 0 \text{ and } \alpha_i^* = 0,\ \forall i \end{cases}$$

Lemma 4: *Under voluntary private insurance and imperfect information, distortions and willingnesses to pay depend on the type. The distortion induced by the insurance market is higher for* $H-type$ *than for* $L-type$*, the* $H-type$ *is willing to pay more than the* $L-type$ *for consuming the drug.*

Proof: The perception of the drug price Pe_i for an agent i is such that:

$$p_i U(w_0 - \alpha_i - P + x_i P) + (1-p_i)U(w_0 - \alpha_i) = p_i U(w_0 - Pe_i) + (1-p_i)U(w_0) \text{ with } \alpha_i = x_i p_i P$$

and, the critical price P^{c_i} for an agent i depends only on whether he does participate to insurance and is defined by,

$$Pe_i(P^{c_i}) = D \Leftrightarrow$$
$$p_i U(w_0 - \alpha_i - P^{c_i} + x_i P^{c_i}) + (1-p_i)U(w_0 - \alpha_i) = p_i U(w_0 - D) + (1-p_i)U(w_0) \text{ with } \alpha_i = x_i p_i P^{c_i} \quad (c)$$

The perception of price and so, the critical price for each type is defined for the reimbursement level obtained from the program so, at the Rothschild and Stiglitz equilibrium. At the Rothschild and Stiglitz equilibrium, types have not the same level of reimbursement, $H-type$ is fully reimbursed but the $L-type$ is partially reimbursed. Therefore at the Rothschild and Stiglitz equilibrium, the critical price for the $L-type$ is much lower than one of the $H-type$.

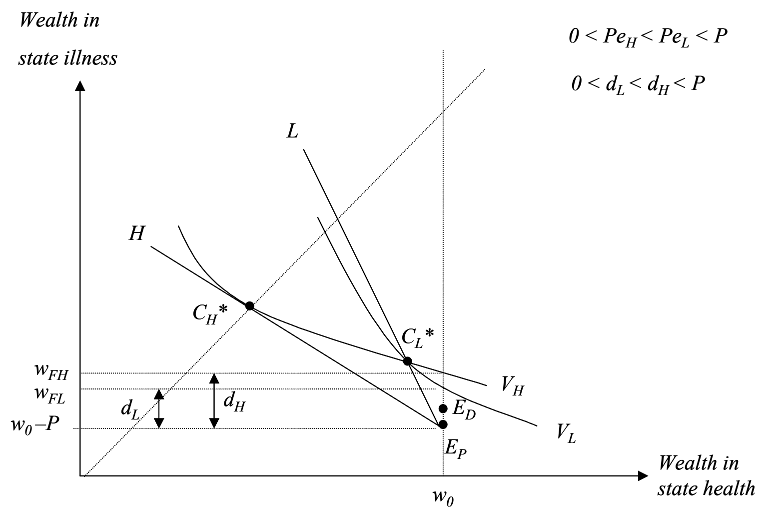


Figure 4: Imperfect information : Voluntary and private insurance when both types are insured

In Figure 4, the medication price is such that the expected utility for uninsured agents that undergo the discomfort is lower than that of the insured agents. So, both types prefer to be insured and consume the medication in state illness. However, other situations can be discussed. The fact that the critical price depends on the type can lead to the situation where only the $H-type$ consumes (Figure 5). Assuming that the drug price is such that the level of wealth after undergoing the discomfort is between w_{FL} and w_{FH}. In such a situation, the $L-type$ prefers not to be insured and to undergo the discomfort whereas the $H-type$ has a better expected utility by choosing to be insured. Thus, there exists an interval of drug price for which only the $H-type$ is insured. At last, for a certain level of discomfort, both types may have a higher expected utility by choosing to be not insured (whenever $V_H(E_D) > V_H(\alpha_H^*, x_H^*)$). In this case, perception of the drug is equal to P and distortion is trivially zero, whatever the type.■

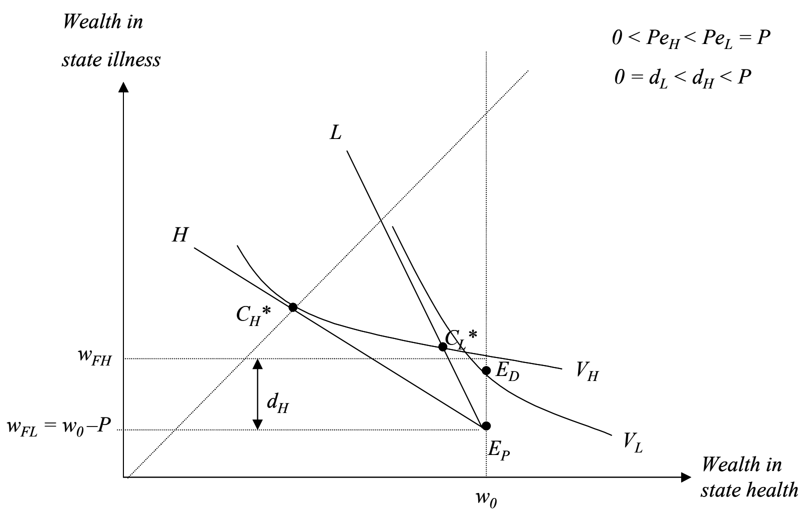


Figure 5: Imperfect information: voluntary and private insurance when only high risks are insured

Now, we compare with the perfect information situation. When probabilities of illness become unobservable for insurers, high risks can masquerade for low risks and choose their contract. So, incentive constraints lead the $L-type$ to be only partially insured, whereas the $H-type$ remains insured with his full information contract. As a consequence of Lemmata 1 and 3, it comes that,

Proposition 1: *Imperfect information leads to a change by "reversal" of individual willingnesses to pay, via a reversal of individual perceptions and distortions.*

In other words, in perfect information, the $H-type$ leaves the insurance market before the $L-type$ and inversely in situation of imperfect information.

Note that under a compulsory system, agents do not have the choice to subscribe the insurance contract. They are under the contract that the insurer offers to them. So, whatever the decision about consumption of the drug, the $L-type$ has to pay the premium α_L^* and she/he consumes as long as $P \leq \frac{D}{(1-x_L)}$. Under a voluntary system, the agent's participation to the insurance market depends on his expected utility. So, there exist cases where under voluntary insurance, the $L-type$ chooses to be uninsured while under compulsory insurance, she/he has to be insured. Figure 1 displays such a configuration. These cases may appear for the $H-type$ too. This remark holds in the public system.

5 Public insurance

By public system, we mean both, a monopolistic insurer regime and no discrimination is practiced. A unique premium α is paid by each individual to a public organism. As example, the "basic" French health insurance can be viewed as administrated by a unique public agency[11]. However, a discrimination based on the income can be done. In this paper, we assume that agents have the same income. The level of coverage x is thus the same for any individual.

For a given price P, the terms (α, x) of the optimal contract are derived from a program in which the public insurer maximizes the social welfare $N_H V_H(\alpha, x) + N_L V_L(\alpha, x)$[12] under an aggregate no-negative profits constraint $\sum_i N_i(\alpha - \overline{p}_i xP) \geq 0$.

In the public regime because discrimination is forbidden, incentive constraints are not consistent. Therefore, there is no difference between the program in perfect information and the program in imperfect information. We study voluntary system and compulsory one. The contract proposed to the agent is the pooling contract noted PC in Figures 6 and 7.

5.1 Compulsory scheme

Optimal public contracts are derived from Program III,

$$\max_{\alpha,x} N[\overline{p}\max\{U(w_0 - \alpha - \min\{D, P\}); U(w_0 - \alpha - P + xP)\} + (1-\overline{p})U(w_0 - \alpha)] \qquad \text{(Program III)}$$

$$s.t. \sum_i N_i(\alpha - \overline{p}_i xP) \geq 0$$

From Appendix C, we obtain a full-insurance pooling i.e. $x^* = 1$ and $\alpha^* = \overline{p}P = \left(\frac{N_H}{N}p_H + \frac{N_L}{N}p_L\right)P$. (see PC in Fig. 6). Not only do individuals have to subscribe a contract but also, a unique premium α is paid by each individual.

[11] In fact, the reality is a little more complex. To sum up, the biggest pourcentage of the population (subpopulation of workers) pays a compulsory premium (contingent to the income), to a unique public agency.

[12] We assume that the insurer adopts a utilitarist behavior, so that the respective weights of H and L in the social welfare function coincide with the proportions of H and L in the population.

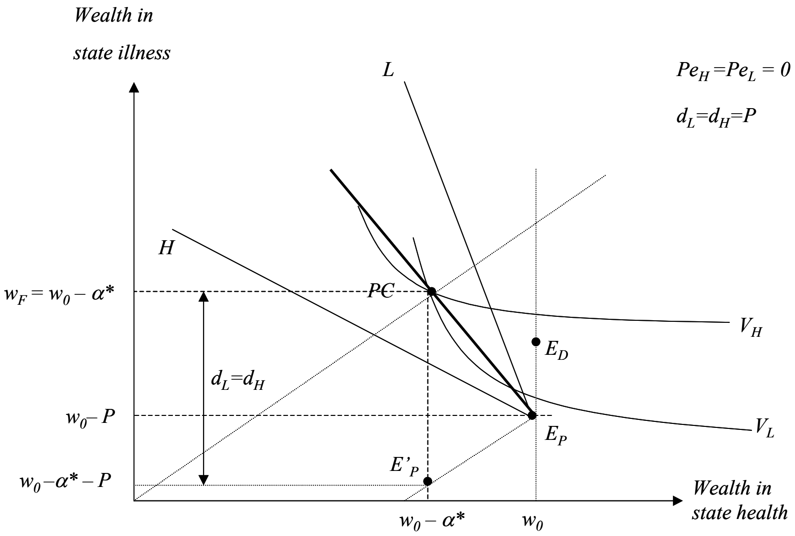


Figure 6: Compulsory and public insurance with full coverage
PC: Pooling contract

From the characteristics of the pooling contract, we derive the following results:

Lemma 5 : *Under compulsory public insurance, the consumption of drug does not depend on the value of P, the drug price. Both types perceive the drug price as being null, whatever the value of P. Insurance market induces the same distortion whatever the type, equal to P, and a unique willingness to pay, unbounded but limited by $\frac{w_0}{\overline{p}}$.*

Proof. Each type of agent has to pay the premium α^* and, in case of illness, each type is fully reimbursed. Henceforth, in state health, the level of wealth of each type is $w_0 - \alpha^*$ and in state illness, each type has to choose between either to consume the medication and to be completely reimbursed (the level of wealth is $w_0 - \alpha^*$) or not to consume the medication and suffer the discomfort D (the level of wealth is $w_0 - \alpha^* - D$). We obtain that whatever the level of P, each type prefers to consume the medication in case of illness ($w_0 - \alpha^* > w_0 - \alpha^* - D$, $\forall P$). *De facto*, the case where only one type i prefers purchasing the drug is not possible.

Moreover, the perception of the price Pe_i does not depend on the type. Indeed, Pe_i is defined by,

$$\overline{p}U(w_0 - \alpha - P + xP) + (1 - \overline{p})U(w_0 - \alpha) = \overline{p}U(w_0 - \alpha - Pe_i) + (1 - \overline{p})U(w_0 - \alpha)$$
$$\Leftrightarrow U(w_0 - \alpha - P + xP) = U(w_0 - \alpha - Pe_i)$$
$$\text{and so } Pe_i\,(P) = P\,(1 - x) \Rightarrow Pe_i\,(P) = Pe\,(P) = 0$$

and the critical price P^{C_i} is unique, defined by

$$Pe_i\,(P^{c_i}) = D$$
$$\Leftrightarrow P^{c_i} = \frac{D}{1 - x}$$

and tends to infinite for $x = 1$. Only the individual wealth limits the willingness to pay.■

In a situation without insurance, the medication price P is bounded by D. Here, the presence of a compulsory public insurance enables the medication price to be unbounded.[13] Indeed, whatever the

[13] Remark that an infinite price does not mean that the types are unsensitive to the price of prescription drug. Indeed, their expected utility is always decreasing in P, whatever the level of x.

price the insured agent has the perception that the drug price is null[14]. Despite the price is unbounded, the maximal price is limited by the wealth of the agent. Note that the maximal price of the drug is such as $w_0 - \alpha^*(P) = 0$ under the **no-loan** assumption. Thus the price is limited by $\frac{w_0}{\overline{p}}$.

5.2 Voluntary scheme

Even if no discrimination is practiced in the public regime, the agent has the choice to participate to the insurance market. However, contrarily to competitive system with voluntary insurance, only one contract (α, x) is proposed in the market, whatever the agent type. Program IV may thus be written as,

$$\max_{\alpha,x} \sum_i N_i\{max\{V_i(0,0); V_i(\alpha,x)\}\} \quad \text{(Program IV)}$$
$$s.t. \sum_i N_i(\alpha - \overline{p}_i x P) \geq 0$$

Depending on which type(s) i do(es) participate to insurance, four subcases appear. From Appendix D, we find that,

$$\begin{cases} \text{When both types are insured } x^* \leqq 1 \text{ and } \alpha^* = x^* \left(\frac{N_H}{N} p_H + \frac{N_L}{N} p_L \right) P \\ \text{When only the high risks are insured but not the low risks, } x^* = 1 \text{ and } \alpha^* = p_H P \\ \text{When no type is insured, } x^* = 0 \text{ and } \alpha^* = 0 \end{cases}$$

Both types participate and definition of the $L - type$ critical price It is important to remark that in a standard insurance model where $P = D$, the solution of the program would lead to a full insurance for both types. Given P can be different from D, we get that both types either are fully insured (PC in Fig. 7) or partially insured (PC' in Fig. 7).

We explain below the mechanism that leads the insurer to propose $x^* < 1$. Starting from one case where $x^* = 1$ in which $L - type$ does not participate to the insurance market (Figure 7). Because we are in the case where $P > D$, he prefers not to consume the drug. Then, the pooling contract would concern only the $H - type$. Arrow 1 in Fig. 7 shows the variation of $H - type$'s expected utility depending on the participation of the $L - type$. Some situations exist where the insurer is able to improve the expected utility of both types by proposing a level of reimbursement $x^* < 1$ (Arrows 2 and 3 in Fig. 7).

[14] To counterbalance this remark, it has to be noticed that in case of a unique insurance, on the drug market, the power to negotiate the medication price is optimal for the demander (here the insurer). So, the level of the medication price could be inferior to D depending on the power of negotiation between the public insurer and the pharmaceutical industry.

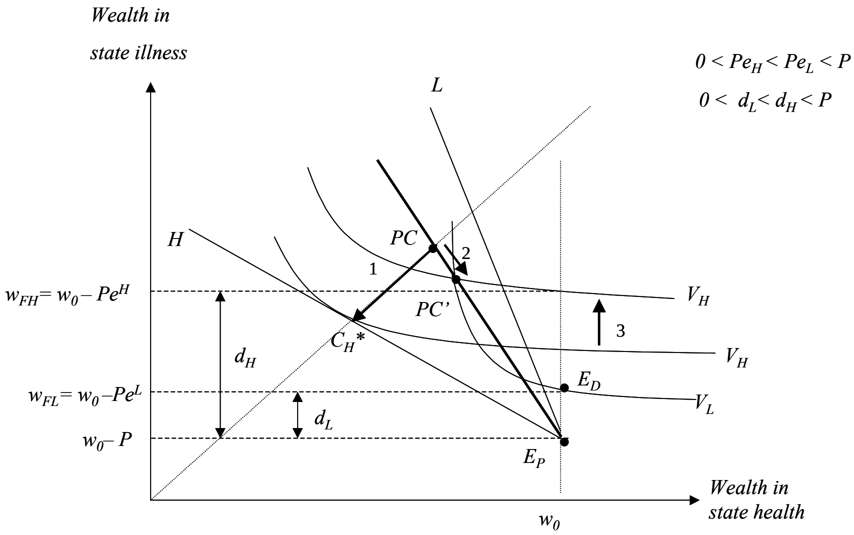


Figure 7: Voluntary and public insurance with full (PC) or partial (FC') coverage
PC: Pooling contract

As in private insurance, the definition of critical price depends on which type(s) participate(s) to insurance market, under a voluntary scheme. So, to a pooling contract is associated two individual perceptions of the drug price, Pe_i, defined by,

$$p_iU(w_0 - \alpha - P + xP) + (1 - p_i)U(w_0 - \alpha) = p_iU(w_0 - Pe_i) + (1 - p_i)U(w_0)$$
$$\text{with } \alpha = x\left(\tfrac{N_H}{N}p_H + \tfrac{N_L}{N}p_L\right)P \text{ and } x \leqq 1$$

A pooling contract is proposed when both types participate to the insurance market. If $L - type$ agents participate, $H - type$ agents necessarily do. So, the critical price, P^{c_L} is defined by the L's participation to the pooling contract,

$$Pe_L\left(P^{c_L}\right) = D$$

One type participates and definition of the $H - type$ critical price The situation where only $H - type$ is insured is possible. In this situation, $L - type$ obtains a better expected utility being uninsured (and undergoing the discomfort in case of illness) than being insured. So, the $L - type$ does not participate in the insurance market. *De facto* the contract proposed to the $H - type$ agents corresponds to their full insurance separated contract C_H^*.

As in private system, for the $L - type$, the perception of the price is the price P when he leaves the insurance market. For the $H - type$, the perception of the drug price corresponds to Pe_H and is defined by the indifference of high risks between to participate or not to participate at the insurance market:

$$U(w_0 - \alpha_H) = p_HU(w_0 - Pe_H) + (1 - p_H)U(w_0) \text{ with } \alpha_H = p_HP$$

As a result, under a voluntary scheme, the perception of the drug price (and so, the critical price) does not depend on the public or private regime when only $H - type$ is insured. Therefore, the perception of the drug price (respectively, the critical price) is the same as the one found in the private regime. Perceptions and distortions of the drug price are displayed in Figure 5.

None participates An extreme situation exists where the pooling contract will not be chosen by any type. Whatever the level of reimbursement $x \leqq 1$, $L - type$ does not participate to the insurance market. In addition, the expected utility of the $H - type$ insured in C_H^* is lower than the expected utility of the uninsured $H-type$ who undergoes the discomfort D in case of illness. So, both types would decide to suffer the discomfort in case of illness by remaining uninsured. In this case, the perception of both types is the price P and the distortion is trivially zero.

From these three configurations, it comes that,

Lemma 6: *Under a voluntary scheme, the willingness to pay for the $H-type$ does not depend on the regime (private or public). The willingness to pay for the $L-type$ does depend on the regime and is lower than the one of the $H-type$, regardless the information (perfect or asymmetric).*

From Lemmata 5 and 6, we obtain this following proposition,

Proposition 2: *Under a public regime, the perception of the price is zero in a compulsory scheme whereas the perception is always strictly positive in a voluntary scheme, even for an individual fully insured.*

6 Comparison between the different forms of insurance market

The insurance system has an effect on the individual perception of price. The consumption of drug is completely depending on both the presence of insurance and the insurance market organisation.

Proposition 3: *For all prices such that $P \leq D$, the prescription drug is always consumed in case of illness and the consumption does not depend on the agent type. For $P > D$, the prescription drug is not consumed by uninsured agent but can be consumed by insured agent.*

Because the consumption of prescription drug depends on both the insurance market organisation and the subscription to an insurance contract, the insurance system distorts the individual perception of price. Moreover, the distinction between the price and the discomfort leads to unusual situations : *under a voluntary insurance, only one type or even no type may actually consume the prescription drug, even in competition.*

Concerning the results on the consumption for prescription drugs, we sum up the results according to the form of insurance system

Insurance system	Level of the willingness to pay according to the type of risk	Consumption of drug price according to the type of risk
Private Compulsory	$P \leq \frac{D}{1-x_i} \to \infty$ in full information $P \leq \frac{D}{1-x_L}$ in asymmetric information	$p_H N_H + p_L N_L$
Private Voluntary	$P \leq P^{C_H}$ in full information $P \leq P^{C_L}$ in asymmetric information	$p_H N_H + p_L N_L$
	$P^{C_H} < P \leq P^{C_L}$ in full information	$p_L N_L$
	$P^{C_L} < P \leq P^{C_H}$ in asymmetric information	$p_H N_H$
	$P > P^{C_L}$ in full information $P > P^{C_H}$ in asymmetric information	0
Public Compulsory	$P \leq \frac{D}{1-x} \to \infty$	$p_H N_H + p_L N_L$
Public Voluntary	$P \leq P^{C_L}$ $P^{C_L} < P \leq P^{C_H}$ $P > P^{C_H}$	$p_H N_H + p_L N_L$ $p_H N_H$ 0

Proposition 4: *The individual willingness to pay is always higher in a compulsory system than in a voluntary one but for a private regime and imperfect information. For the latter case, this assertion is true only with the restriction $\frac{p_H}{1-x_L} > 1$.*

Proof. See Appendix E.

Proposition 5: *Whatever the insurance system with imperfect information, the distortion is higher for the $H-type$ than for the $L-type$. In addition, whatever the type, the distortion is higher under a compulsory scheme than under a voluntary scheme.*

Note that with full information, the first part of this proposition is not verified under a *private* regime. More exactly, we have shown that individual distortion is higher for the $L-type$ than for the $H-type$. The second part of this proposition is true whatever the level of information.

Proposition 6: *Under perfect and imperfect information, a voluntary scheme Pareto-dominates a compulsory scheme in private regime whereas this holds no more longer in a public regime.*

Proof.
Indeed, we have three situations in the private regime:
- both types are indifferent between the two schemes,
- one type[15] prefers a voluntary system because he has the possibility to leave the insurance market, and the other is indifferent
- both types prefer a voluntary system because they have the possibility to leave the insurance market.

In contrast, in the public regime, some situations exist where high risks are better off under a compulsory scheme ($x^* = 1$) than a voluntary one ($x^* < 1$) and low risks are better off under a voluntary scheme than a compulsory one (see Fig. 6).■

Analogy between a competitive system with compulsory insurance and a regulated system
We consider now an intermediate regime in which individuals are identically covered by an insurer[16] that individuals choose amongst competitive insurers. Such a competitive but regulated organisation could be found in the Netherlands. In this country, the level of coverage is identical whatever the agent. He can choose between different public or private insurers.[17] Other example can be found in the US with the health insurance contract bound to the working contract. In some cases, the level of coverage is identical for all company workers and the premium depends on the income. We can expect that such a system could simultaneously allow competition and warrant for consumers to obtain an homogenous coverage, i.e. without discrimination about the individual characteristics.

Indeed, given the regulation required on x, insurers cannot discriminate about the contractual level of coverage such that $x_i = x$ whatever $i = H, L$. As a consequence, it is not pertinent for insurers to propose different premia against the same level of reimbursement. Given the competitive environment, any individual will be proposed the same contract by any insurer (offering the lowest premium among the set of proposed contracts).

The critical price under this system is defined like the one described in Section 5.1. Note that the critical price may be *in fine* different from the critical price found for a public system depending on the level of reimbursement established in this system.

7 Conclusion

This paper has assessed the impact of insurance market organisation on the price of prescription drugs. We illustrate the results in the context of health economics. In contrast with a classic model à la Rothschild and

[15] High risk under perfect information and low risk under imperfect information.
[16] The level of coverage is identical whatever the patient.
[17] In fact, the coverage is based on the income for 75 % of the premium. The remaining 25 % depends on the insurer.

Stiglitz (1976), there is a difference between the monetary evaluation of the discomfort caused by illness and the medication price. We focus on the adverse effects on access to drugs and the form of health insurance system: compulsory versus voluntary, and private versus public.

The perception of price coincides with the *out-of-pocket price* under the compulsory scheme. However, it may differ from the universal notion of *out-of-pocket*, as here it takes into account the probability that the individual participates in the insurance market.

In a insurance model without introducing a moral hazard parameter, we show that the prescription drug is always consumed when its price is less than or equal to the monetary evaluation of the discomfort, and only the presence of an insurance market allows its consumption at a higher price. In the extreme, the distortion induced by an insurance market (for instance, a compulsory public insurance system) leads the agent to perceive a zero price, whatever the actual drug price may be. Therefore, the pharmaceutical industry prefers the public compulsory scheme. For the agent, under both perfect and imperfect information, a compulsory scheme Pareto-dominates a voluntary scheme in the private regime, whereas this no longer holds in the public regime.

In our model, for a prescription to be sold, its price has to be less than or equal to the willingness to pay. Under the private regime, perfect information leads the willingness to pay of low risk individuals to be higher than that of high risk individuals. The exit option is thus chosen at a higher price by the low risk than the high risk. This situation reflects what is observed in various insurance markets. For instance, bad drivers have difficulties in finding private insurance contracts except at high premia because their characteristics are at least partially observable. This is reversed under asymmetric information: high risk individuals participate in the insurance market at a higher level of drug price than do low risk individuals.

At a given drug price, we show that the the quantity demanded of the drug is higher under the compulsory regime than under the voluntary regime. Some individuals consume the drug under the compulsory regime whereas they would not consume under the voluntary regime, because they would not participate in the insurance market. In our paper, the distinction between price and discomfort may lead to a situation where only one type consumes the prescription drug even under competition, *i.e.* the prescription price for this type is superior to his/her willingness to pay. This situation never exists in the classic model under competition because price is at the level where all agents are willing to pay. The exclusion of one group raises a public health issue.

Our analysis is based on the assumption that the drug price is exogenous. However, the presence of insurance has an effect on this price. The insurer acts on behalf of the agent for the demand of the prescription drug. Were the drug price to result from negotiation between insurers and the drug industry, insurers' bargaining power would be inversely correlated with the number of insurance companies. The introduction of an endogenous drug price in our model would lead to more ambiguous results as we show that, in the case of a sole public insurer, drug prices may be limited only by individual wealth.

In our model, we consider separately different types of insurance schemes. As in Hoel and Iversen (2002), we could imagine a system where the insured agents can choose, complementary coverage in addition to their compulsory insurance.

These results shed some light on the current debate over the reform of health systems world-wide, and particularly in France. These results may provide a framework in which to think about the issue of drug prices and their relation to the insurance system. However, health status is a subjective notion, and the perception of health status can be manipulated by the drug industry, as explained by Moynihan *et alii* (2002), doctors and/or the regulator. Further reasearch in this context could consider the impact of these actors on the demand for prescription drugs in the context where the discomfort can be different from the prescription price.

8 Appendix

8.1 Appendix A: Private system with compulsory insurance

In order to characterize the optimal contracts under compulsory insurance, it is necessary to derive first order conditions.

The Lagrangean of Program 1 is :

$$\begin{aligned} L = \; & p_L \max\{U(w_0 - \alpha_L - P + x_L P); U(w_0 - \alpha_L - \min\{P; D\})\} + (1-p_L)U(w_0 - \alpha_L) \\ & + \Sigma_{i=H,L}\delta_i[p_i \max\{U(w_0 - \alpha_i - P + x_i P); U(w_0 - \alpha_i - \min\{P; D\})\} + (1-p_i)U(w_0 - \alpha_i) \\ & - p_i \max\{U(w_0 - \alpha_k - P + x_k P); U(w_0 - \alpha_k - \min\{P; D\})\} + (1-p_i)U(w_0 - \alpha_k)] \\ & + \Sigma_{i=H,L}\mu_i N_i(\alpha_i - \overline{p}_i x_i P) \end{aligned}$$

with δ_i and μ_i the multiplicators associated to the incentive and profit constraints respectively. It is trivial to show that any competitive regime implies that the no-negative profit constraints are binding. Thus $\mu_i > 0$ for each type i.

Insurance being compulsory, $P \leq P^{C_i}$ $\forall i \in \{H, L\}$ i.e. both types consume the drug $\overline{p}_i = p_i$ $\forall i \in \{H, L\}$. The first order conditions relative to α_i and x_i are Equations (1) to (4):

$$[-p_L + \delta_H p_H - \delta_L p_L]U'(w_0 - \alpha_L - P + x_L P) + [\delta_H(1-p_H) - (\delta_L + 1)(1-p_L)]U'(w_0 - \alpha_L) + \mu_L N_L = 0 \tag{6}$$

$$[-\delta_H p_H + \delta_L p_L]U'(w_0 - \alpha_H - P + x_H P) + [-\delta_H(1-p_H) + \delta_L(1-p_L)]U'(w_0 - \alpha_H) + \mu_H N_H = 0 \tag{7}$$

$$[p_L - \delta_H p_H + \delta_L p_L]U'(w_0 - \alpha_L - P + x_L P) = \mu_L N_L p_L \tag{8}$$

$$[\delta_H p_H - \delta_L p_L]U'(w_0 - \alpha_H - P + x_H P) = \mu_H N_H p_H \tag{9}$$

Four subcases are possible depending on which incentive constraint(s) do(es) hold. It is easy to show that only high risks' incentive constraint is binding $\delta_H > 0$ and $\delta_L = 0$ so that the optimal contracts are the Rothschild and Stiglitz contracts. (For a formal demonstration, see Fombaron and Milcent (2005)). (2) and (4) imply $\boxed{x_H^* = 1}$ and from the no-negative profit constraint $\boxed{\alpha_H^* = p_H P}$. Moreover, $\delta_L = 0$ in Equations (4) and (2) leads to

$$\frac{U'(w_0 - \alpha_L - P + x_L P)}{U'(w_0 - \alpha_L)} = \frac{p_L(1-p_L) - \delta_H p_L(1-p_H)}{p_L(1-p_L) - \delta_H p_H(1-p_L)} > 1$$

implying that $\boxed{x_L^* < 1}$ and $\boxed{\alpha_L^* = x_L^* p_L P}$ since $p_L < p_H$.

Recall that the compulsory character implicitely requires that a premium strictly positive ($\alpha_i > 0$ $\forall i$) is demanded against the promise of a positive coverage ($x_i > 0$ $\forall i$). Therefore, $P > P^{C_i}$ for at least one $i \in \{H, L\}$ implies that the drug is not consumed for both types anymore. A regime of no-insurance prevails.

8.2 Appendix B: Private system with voluntary insurance

Program II can be rewritten as below

$$\underset{\alpha_i, x_i}{Max}\; max\{p_L U(w_0 - \min\{D; P\}) + (1-p_L)U(w_0); p_L U(w_0 - \alpha_L - P + x_L P) + (1-p_L)U(w_0 - \alpha_L)\}$$

subject to

$$max\{p_i U(w_0 - \min\{D; P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha_i - P + x_i P) + (1-p_i)U(w_0 - \alpha_i)\} \geq$$
$$max\{p_i U(w_0 - \min\{D; P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha_k - P + x_k P) + (1-p_i)U(w_0 - \alpha_k)\}$$
$$i, k \in \{H, L\}, i \neq k$$

$$N_i(\alpha_i - \overline{p}_i x_i P) \geq 0 \;\; i \in \{H, L\}$$

$$
\begin{aligned}
L = & \, max\{p_L U(w_0 - \min\{D;P\}) + (1-p_L)U(w_0); p_L U(w_0 - \alpha_L - P + x_L P) + (1-p_L)U(w_0 - \alpha_L)\} \\
& + \Sigma_{i=H,L}\delta_i [max\{p_i U(w_0 - \min\{D;P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha_i - P + x_i P) + (1-p_i)U(w_0 - \alpha_i)\} \\
& - max\{p_i U(w_0 - \min\{D;P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha_k - P + x_k P) + (1-p_i)U(w_0 - \alpha_k)\}] \\
& + \Sigma_{i=H,L}\mu_i N_i(\alpha_i - \overline{p}_i x_i P)
\end{aligned}
$$

Four subcases must be analyzed depending on the consumption of each type i.

Since in this regime, participation implies consumption and reciprocally[18], we have formally

$$
\begin{aligned}
& V_i(\alpha_i, x_i) \geq V_i(0,0) \Leftrightarrow max\{V_i(0,0); V_i(\alpha_i, x_i)\} = V_i(\alpha_i, x_i) \text{ and} \\
& V_i(\alpha_i, x_i) < V_i(0,0) \Leftrightarrow max\{V_i(0,0); V_i(\alpha_i, x_i)\} = V_i(E_D)
\end{aligned}
$$

so that any uninsured agent is located in E_D.

• **1.** $P \leq P^{v_i}$ $\forall i \in \{H, L\}$ i.e. both types consume the drug $\overline{p}_i = p_i$ $\forall i \in \{H, L\}$**.**

Each type consumes the drug when he participates to insurance market. This situation occurs when $max\{V_i(0,0); V_i(\alpha_i, x_i)\} = V_i(\alpha_i, x_i)$ for $i \in \{H, L\}$. Even if Program II differs from Program I, first order conditions after few manipulations are similar to the ones found in Appendix A and optimal contracts under voluntary insurance correspond with Rothschild/Stiglitz' contracts:

$$
\boxed{x_H^* = 1,\ \alpha_H^* = p_H P,\ x_L^* < 1 \text{ and } \alpha_L^* = x_L^* p_L P.}
$$

• **2.** $P > P^{v_i}$ $\forall i \in \{H, L\}$ i.e. none consumes the drug $\overline{p}_i = 0$

This case occurs when no type is insured : $max\{V_i(0,0); V_i(\alpha_i, x_i)\} = V_i(0,0)$ for $i \in \{H, L\}$. In terms of price, this case can only occur when $P > P^{C_i}$ $\forall i \in \{H, L\}$. That means no type consumes in case of illness. Optimal contracts are trivially, $\boxed{x_i^* = 0 \text{ and } \alpha_i^* = 0\ \forall i \in \{H, L\}}$.

• **3.** $P^{v_H} < P \leq P^{v_L}$ i.e. only low risks consume: $\overline{p}_H = 0$ and $\overline{p}_L = p_L$.

Formally, $max\{V_L(0,0); V_L(\alpha_L, x_L)\} = V_L(\alpha_L, x_L)$ and $max\{V_H(0,0); V_H(\alpha_H, x_H)\} = V_H(0,0)$. We show that this case where only low risks participate to insurance market can never arise. Indeed, if there exists a contract (α_L, x_L) which is preferred to no-insurance by low risks, this contract will be necessarily preferred to no-insurance by high risks. More formally, we prove that

$$
V_L(\alpha_L, x_L) \geq V_L(0,0) \text{ implies } V_H(\alpha_L, x_L) \geq V_H(0,0).
$$

Indeed, the first inequality is equivalent to

$$
p_L\left[U(w_0 - \alpha_L - P + x_L P) - \max\{U(w_0 - P); U(w_0 - D)\}\right] + (1 - p_L)\left[U(w_0 - \alpha_L) - U(w_0)\right] \geq 0.
$$

Moreover, $U(w_0 - \alpha_L) - U(w_0) < 0$ implies that $U(w_0 - \alpha_L - P + x_L P) - \max\{U(w_0 - P); U(w_0 - D)\} > 0$ given that low risks subscribe an insurance contract.

Furthermore, since $p_H > p_L$, the following inequality

$$
p_H \underbrace{[U(w_0 - \alpha_L - P + x_L P) - \max\{U(w_0 - P); U(w_0 - D)\}]}_{>0} + (1 - p_H)\underbrace{[U(w_0 - \alpha_L) - U(w_0)]}_{<0} > 0
$$

is ever satisfied. Thus,

$$
V_H(\alpha_L, x_L) \geq V_H(0,0)
$$

such that there exists no contract which would be preferred to no-insurance by low-risks and would not be subscribed by high risks.

[18] See Section 4.2 for more explanation.

4. $P^{v_L} < P \leq P^{v_H}$ i.e. only high risks consume: $\overline{p}_H = p_H$ and $\overline{p}_L = 0$

It occurs when $max\{V_H(0,0); V_H(\alpha_H, x_H)\} = V_H(\alpha_H, x_H)$ and $max\{V_L(0,0); V_L(\alpha_L, x_L)\} = V_L(0,0)$. Then first order conditions (2) and (4) relative to α_H and x_H implying after few manipulations:

$$[\frac{(1-p_H)(p_H\delta_H - p_L\delta_L)}{p_H}]U'(w_0 - \alpha_H - P + x_H P) + [\delta_H + \delta_L - p_H\delta_H - p_L\delta_L]U'(w_0 - \alpha_H) = 0$$

$$\Leftrightarrow \quad \frac{U'(w_0 - \alpha_H - P + x_H P)}{U'(w_0 - \alpha_H)} = \frac{(p_H\delta_H - p_H\delta_L - p_H^2\delta_H + p_H p_L \delta_L)}{(p_H\delta_H - p_L\delta_L - p_H^2\delta_H + p_H p_L \delta_L)}$$

Moreover, if $\delta_L > 0$ or in other words if the incentive constraint of low risks is binding, the two types would be offered the same contract. Clearly, a pooling contract would be incompatible with the individual profit constraints. Thus the L's incentive constraint does hold with a strict inequality, implying $\delta_L = 0$ and consequently $\frac{U'(w_0-\alpha_H-P+x_H P)}{U'(w_0-\alpha_H)} = 1$. In terms of premium and indemnity, we obtain $\boxed{\alpha_H^* = p_H P,\ x_H^* = 1,\ \alpha_L^* = 0 \text{ and } x_L^* = 0}$ that means *L-types* leave the insurance market and the drug market, while *H-types* consume and are fully reimbursed.

8.3 Appendix C: Public system with compulsory insurance

For a given price P, the terms (α, x) of the optimal contract are derived from Program III in which the monopolistic insurer maximizes the social welfare under an aggregate no-negative profits constraint:

$$\max_{\alpha,x} N[\overline{p}\max\{U(w_0 - \alpha - P + xP); U(w_0 - \alpha - \min\{D;P\})\} + (1-\overline{p})U(w_0 - \alpha)]$$

$$s.t. \sum_i N_i(\alpha - \overline{p}_i x P) \geq 0$$

$$L = N[\overline{p}\max\{U(w_0 - \alpha - P + xP); U(w_0 - \alpha - \min\{D;P\})\} + (1-\overline{p})U(w_0 - \alpha)] + \mu\sum_i N_i(\alpha - \overline{p}_i x P)$$

Insurance being compulsory, $P \leq \tilde{P}^{C_i}$ $\forall i \in \{H, L\}$ i.e. both types consume the drug $\overline{p}_i = p_i$ $\forall i \in \{H, L\}$. Formally,

$$\max\{U(w_0 - \alpha - P + xP); U(w_0 - \alpha - \min\{P;D\})\} = U(w_0 - \alpha - P + xP)$$

and the first order conditions relative to α and x are

$$-(N_H p_H + N_L p_L)U'(w_0 - \alpha - P + xP) - (N - N_H p_H - N_L p_L)U'(w_0 - \alpha) + \mu N = 0 \tag{10}$$

$$(N_H p_H + N_L p_L)PU'(w_0 - \alpha - P + xP) = \mu(N_H p_H + N_L p_L)P \tag{11}$$

that leads to

$$\frac{U'(w_0 - \alpha - P + xP)}{U'(w_0 - \alpha)} = 1 \text{ i.e. } \boxed{x^* = 1} and \boxed{\alpha^* = (\frac{N_H}{N}p_H + \frac{N_L}{N}p_L)P}$$

For the same reason as Appendix A, $P > \tilde{P}^{C_i}$ for at least one $i \in \{H, L\}$ is not compatible with a compulsory character of insurance. A no-insurance regime prevails.

8.4 Appendix D: Public system with voluntary insurance

We know consider the Program IV

$$\underset{\alpha_i,x_i}{Max} \sum_i N_i max\{V_i(0,0); V_i(\alpha,x)\}$$
$$s.t. \quad \sum_i N_i(\alpha - \overline{p}_i xP) \geq 0$$

Program IV may be developped as follows

$$\underset{\alpha_i,x_i}{Max} \sum_i N_i max\{p_i U(w_0 - \min\{D;P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha - P + xP) + (1-p_i)U(w_0 - \alpha)\}$$
$$s.t. \quad \sum_i N_i(\alpha - \overline{p}_i xP) \geq 0$$

with μ the multiplicator associated to the aggregate profit constraint. Four subcases must be analyzed depending on which type(s) do(es) consume the drug. Note that under the assumption of voluntary insurance it is not excluded that an uninsured agent consumes ever the drug. Participation to insurance market thus implies the consumption of the drug in case of illness, but the reciprocal assertion does not hold.

- **1.** $P \leq \tilde{P}^{v_i}$ $\forall i \in \{H, L\}$ i.e. both types consume the drug $\overline{p}_i = p_i$ $\forall i \in \{H, L\}$**.**

Both types are insured

In order to maximize the collective welfare, the public regulator can use the participation constraint to incentive the low-risk to prefer the pooling contract to the no-insurance. To take into account this situation, we add the L's participation constraint in the program, $V_L(\alpha, x) \geq V_L(0,0)$. Therefore, the lagrangian is

$$\begin{aligned} L = &\sum_i N_i max\{p_i U(w_0 - \min\{D;P\}) + (1-p_i)U(w_0); p_i U(w_0 - \alpha - P + xP) + (1-p_i)U(w_0 - \alpha)\} \\ &+ \mu \sum_i N_i(\alpha - \overline{p}_i xP) \\ &+ \delta[p_L U(w_0 - \alpha - P + xP) + (1-p_L)U(w_0 - \alpha) - p_L U(w_0 - \min\{D;P\}) - (1-p_L)U(w_0)] \end{aligned}$$

with $\delta \geq 0$, the multiplicator associated to the participation constraint.

The first order conditions are,

$$\begin{aligned} -(N_H p_H + N_L p_L)U'(w_0 - \alpha - P + xP) - (N - N_H p_H - N_L p_L)U'(w_0 - \alpha) \\ + \mu N - \delta p_L U'(w_0 - \alpha - P + xP) - \delta(1-p_L)U'(w_0 - \alpha) = 0 \end{aligned} \tag{12}$$

$$(N_H p_H + N_L p_L)PU'(w_0 - \alpha - P + xP) - \mu(N_H p_H + N_L p_L)P + \delta p_L U'(w_0 - \alpha - P + xP)P = 0 \tag{13}$$

From (13),

$$\mu = \frac{((N_H p_H + N_L p_L) + \delta p_L)U'(w_0 - \alpha - P + xP)}{(N_H p_H + N_L p_L)}$$

And with (1),

$$\frac{U'(w_0 - \alpha)}{U'(w_0 - \alpha - P + xP)} = \frac{((N_H p_H + N_L p_L) + \delta p_L)(-1 + \frac{N}{(N_H p_H + N_L p_L)})}{(N - (N_H p_H + N_L p_L) + \delta(1 - p_L))}$$

$$\Longleftrightarrow \frac{U'(w_0 - \alpha)}{U'(w_0 - \alpha - P + xP)} = \frac{-(N_H p_H + N_L p_L)^2 + N(N_H p_H + N_L p_L) - \delta p_L(N_H p_H + N_L p_L) + \delta p_L N}{-(N_H p_H + N_L p_L)^2 + N(N_H p_H + N_L p_L) - \delta p_L(N_H p_H + N_L p_L) + \delta(N_H p_H + N_L p_L)}$$

→ When $\delta = 0$ the right member is equal to 1 so that $\boxed{x^* = 1}$ and $\boxed{\alpha^* = (\frac{N_H}{N} p_H + \frac{N_L}{N} p_L)P}$.

→ when $\delta > 0$, being that $\delta p_L N < \delta(N_H p_H + N_L p_L)$,

if $(N - N_H p_H - N_L p_L - \delta p_L + \delta) > 0$, the right member is inferior to 1 so that $\boxed{x^* < 1}$ and $\boxed{\alpha^* = x(\frac{N_H}{N} p_H + \frac{N_L}{N} p_L)P}$

None is insured : The case where both types consume and are not insured is not possible because this situation is always dominated by the Rothschild and stiglitz contract offered to the H type.

One type insured : de facto, if both consume the only type who can be insured is the H type. Indeed, we can show that no contract exists which would be preferred to no-insurance by low risks and would not be subscribed by high risks, i.e. that

$$\max\{V_L(0,0), V_L(\alpha, x)\} = V_L(\alpha, x) \Longrightarrow \max\{V_H(0,0), V_H(\alpha, x)\} = V_H(\alpha, x)$$

Only high risks are insured implies $\max\{V_H(0,0), V_H(\alpha, x)\} = V_H(\alpha, x)$ and $\max\{V_L(0,0), V_L(\alpha, x)\} = V_L(0,0)$. Thus we have necessarily $\overline{p}_H = p_H$. Moreover $\overline{p}_L = p_L$ occurs when $P < D$, so that $V_L(0,0) = V_L(E_P)$, and the Lagrangean is

$$\begin{aligned} L = & N_H[p_H U(w_0 - \alpha - P + xP) + (1 - p_H)U(w_0 - \alpha)] \\ & + N_L[p_L U(w_0 - P) + (1 - p_L)U(w_0)] + \mu N_H(\alpha - (p_H x)\, P) \quad \text{avec } x = x_H \text{ and } x_L = 0 \end{aligned}$$

So, we obtain also $x^* = 1$ and $\alpha^* = p_H P$, but here (that is when the drug would be too purchased by each type in a world without insurance) the type excluded of insurance market chooses ever to treat his illness rather than to suffer the discomfort.

• **2.** $P > \tilde{P}^{v_i}$ $\forall i \in \{H, L\}$ i.e. none consumes the drug $\overline{p}_i = 0$. This case implies that both are not insured so, $\alpha^* = x^* = 0$.

• **3.** $\tilde{P}^{v_H} < P \leq \tilde{P}^{v_L}$ i.e. only low risks consume: $\overline{p}_H = 0$ and $\overline{p}_L = p_L$.

L type insured implies $\max\{V_H(0,0), V_H(\alpha, x)\} = V_H(0,0)$ and $\max\{V_L(0,0), V_L(\alpha, x)\} = V_L(\alpha, x)$. This configuration would imply $\overline{p}_L = p_L$ and $\overline{p}_H = 0$. By a similar argument as before, no contract exists which would be preferred to no-insurance by low risks and would not be subscribed by high risks.

L type uninsured. This case implies that both are not insured. The decision of consumption does not depend of the type. Therefore, we cannot have one type who consumes and not the other.

4. $\tilde{P}^{v_L} < P \leq \tilde{P}^{v_H}$ i.e. only high risks consume: $\overline{p}_H = p_H$ and $\overline{p}_L = 0$

H type insured. The Lagrangean is

$$\begin{aligned} L = & N_H[p_H U(w_0 - \alpha - P + xP) + (1 - p_H)U(w_0 - \alpha)] \\ & + N_L[p_L U(w_0 - D) + (1 - p_L)U(w_0)] + \mu N_H(\alpha - p_H x P) \end{aligned}$$

and the first order conditions are:

$$-N_H p_H U'(w_0 - \alpha - P + xP) - N_H(1 - p_H)U'(w_0 - \alpha) + \mu N_H = 0 \quad (14)$$

$$N_H p_H P U'(w_0 - \alpha - P + xP) - \mu N_H p_H P = 0 \quad (15)$$

that imply that $x^* = 1$ and $\alpha^* = p_H P$.

H type uninsured. This case implies that both are not insured. The decision of consumption does not depend of the type. Therefore, we cannot have one type who consumes and not the other.

8.5 Appendix E: Proof of Proposition 6

We distinguish $P_v^{c_i}$ the critical price under a voluntary scheme from $P_c^{c_i}$ the critical price under a compulsory scheme.

- For both types in a public regime regardless the level of information :

In a compulsory system, the price is bounded by the initial endowment of the agent. In the public voluntary one, it is bounded to $P_v^{c_L}$ for the $L-type$ and it is bounded to $P_v^{c_H}$ for the $H-type$. Therefore, the critical price is always higher in a compulsory system than in a voluntary one.

- For both types in a private regime under perfect information : the same argument as for the public regime is true here.

- For both types in a private regime under imperfect information:

The situation is more complicated. (a) For the $L-type$, the price is bounded to $\frac{D}{1-x_L}$ in a compulsory system and it is bounded to $P_v^{c_L} < \frac{D}{1-x_L}$ in the voluntary one. (b) For the $H-type$, there is no clear-cut result. We show a sufficient condition for the critical price to be higher in a compulsory system than in a voluntary one.

$P_v^{c_i}$ is defined by

$$p_i U(w_0 - \alpha_i - P_v^{c_i} + x_i P_v^{c_i}) + (1-p_i)U(w_0 - \alpha_i) = p_i U(w_0 - D) + (1-p_i)U(w_0) \text{ with } \alpha_i = x_i p_i P_v^{c_i} \quad \text{(A)}$$

Because $P_c^{c_L} = \frac{D}{1-x_L}$,

$$w_0 - \alpha_i - P_c^{c_L} + x_i P_c^{c_L} = w_0 - \alpha_i - \left(\frac{1-x_i}{1-x_L}\right) D$$

$$w_0 - (x_i p_i P_c^{c_L}) - P_c^{c_L} + x_i P_c^{c_L} = w_0 - (x_i p_i P_c^{c_L}) - \left(\frac{1-x_i}{1-x_L}\right) D \quad \text{(B)}$$

(a) If $x_i = x_L$ then $\left(\frac{1-x_i}{1-x_L}\right) = 1$

$p_L U(w_0 - \alpha_L - D) < p_L U(w_0 - D)$ implies
$p_L U(w_0 - \alpha_L - D) + (1-p_L)U(w_0) < p_L U(w_0 - D) + (1-p_L)U(w_0)$
from (A), $p_L U(w_0 - \alpha_L - D) + (1-p_L)U(w_0) < p_L U(w_0 - \alpha_L - P_v^{c_L} + x_L P_v^{c_L}) + (1-p_L)U(w_0 - \alpha_L)$
from (B),
$p_L U(w_0 - \alpha_L - P_c^{c_L} + x_L P_c^{c_L}) + (1-p_L)U(w_0) < p_L U(w_0 - \alpha_L - P_v^{c_L} + x_L P_v^{c_L}) + (1-p_L)U(w_0 - \alpha_L)$
$\Leftrightarrow p_L U(w_0 - \alpha_L - (1-x_L) P_c^{c_L}) + (1-p_L)U(w_0) < p_L U(w_0 - \alpha_L - (1-x_L) P_v^{c_L}) + (1-p_L)U(w_0 - \alpha_L)$
implying $P_c^{c_L} > P_v^{c_L}$

(b) If $x_i = x_H$ and $x_H^* = 1$,from (B)

$$w_0 - (x_H^* p_H P_c^{c_L}) - P_c^{c_L} + x_H^* P_c^{c_L} = w_0 - p_H P_c^{c_L}$$

Since $P_c^{c_L} = P_c^{c_H}$ in a compulsory private system and $P_c^{c_L} = \frac{D}{1-x_L}$, we obtain

$$w_0 - (x_H^* p_H P_c^{c_L}) - P_c^{c_L} + x_H^* P_c^{c_L} = w_0 - \frac{p_H}{1-x_L} D$$

Then,

$$p_H U(w_0 - (x_H^* p_H P_c^{c_L}) - P_c^{c_L} + x_H^* P_c^{c_L}) + (1-p_H)U(w_0) = p_H U(w_0 - \frac{p_H}{1-x_L} D) + (1-p_H)U(w_0)$$

And, if $\frac{p_H}{1-x_L} > 1$,

$$p_H U(w_0 - \frac{p_H}{1-x_L} D) + (1-p_H)U(w_0) < p_H U(w_0 - D) + (1-p_H)U(w_0)$$
$$\Leftrightarrow p_H U(w_0 - (x_H^* p_H P_c^{c_L}) - P_c^{c_L} + x_H^* P_c^{c_L}) + (1-p_H)U(w_0) < p_H U(w_0 - D) + (1-p_H)U(w_0)$$
from(A), $p_H U(w_0 - \alpha_H^* - (1-x_H^*)P_v^{c_H}) + (1-p_H)U(w_0 - \alpha_H^*) = p_H U(w_0 - D) + (1-p_H)U(w_0)$
$$\Rightarrow \begin{array}{l} p_H U(w_0 - (x_H^* p_H P_c^{c_L}) - P_c^{c_L} + x_H^* P_c^{c_L}) + (1-p_H)U(w_0) \\ < p_H U(w_0 - \alpha_H^* - (1-x_H^*)P_v^{c_H}) + (1-p_H)U(w_0 - \alpha_H^*) \end{array}$$
$$\Rightarrow \begin{array}{l} p_H U(w_0 - (x_H^* p_H P_c^{c_L}) - (1-x_H^*)\, P_c^{c_L}) + (1-p_H)U(w_0) \\ < p_H U(w_0 - \alpha_H^* - (1-x_H^*)P_v^{c_H}) + (1-p_H)U(w_0) \end{array}$$
Because $\alpha_H^* = x_H^* p_H P_c^{c_H}$, we must have $P_c^{c_H} > P_v^{c_H}$ if $\frac{p_H}{1-x_L} > 1$. ■

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