Introduction to Insurance Economics

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Insurance is the science of pooling risks

Insurance demand results from the willingness of individuals to be protected from exposure to risk.

If a large number of people (individuals or firms) pay some money (premium) into a pool, money can be drawn from the pool to compensate those who might suffer losses.

Insurers write insurance policies and manage the money paid by the policyholders so that they are able to pay out claims at all time.

Risk pooling is the essence of insurance, but insurance also involves risk spreading through reinsurance and capital markets.

Insurance is only one of the mechanisms to mitigate economic risks (risks can also be prevented, self-insured or transferred).

There are many types of insurance policies

Individuals may subscribe...

- life insurance,
- accident insurance,
- health insurance,
- personal liability insurance,
- motor car insurance,
- homeowner's insurance,
- credit insurance,
- travel insurance

and others...

...but corporations also purchase insurance for

- general damages : fire, theft, motor fleet...
- corporate liability: medical malpractice, environmental damages, product liability, employers' liability...
- transportation risks: aircraft liability, marine insurance...
- natural disasters: earthquakes, hurricane, flood, hail...

and others (such as coverage for patent infringement, product recall, e-commerce risks...)

1. Basic Model of Insurance demand

w_0 : initial wealth

w_f : final wealth

▪ : loss in case of accident

$q \in [0,1]$: probability of accident

t = insurance indemnity

P = insurance premium, with

$$P = (1+\sigma)qt$$

qt = fair premium

σ = loading factor

w_1 = final wealth in the « no-accident » state

w_2 = final wealth in the « accident » state

$$w_1 = w_0 - P \quad \text{and} \quad w_2 = w_0 - \blacksquare - P + t$$

$$w_f = w_1 \text{ with probability } 1 - q$$

$$w_f = w_2 \text{ with probability } q$$

The individual is **risk averse**: he(she) chooses his (her) insurance contract (P, t) in order to maximize expected utility

$$\mathbf{E}u(w_f) = (1 - q)\, u(w_1) + q\, u(w_2)$$

with u❖$(w_f) > 0$ and u◆$(w_f) < 0$.

Feasible lotteries

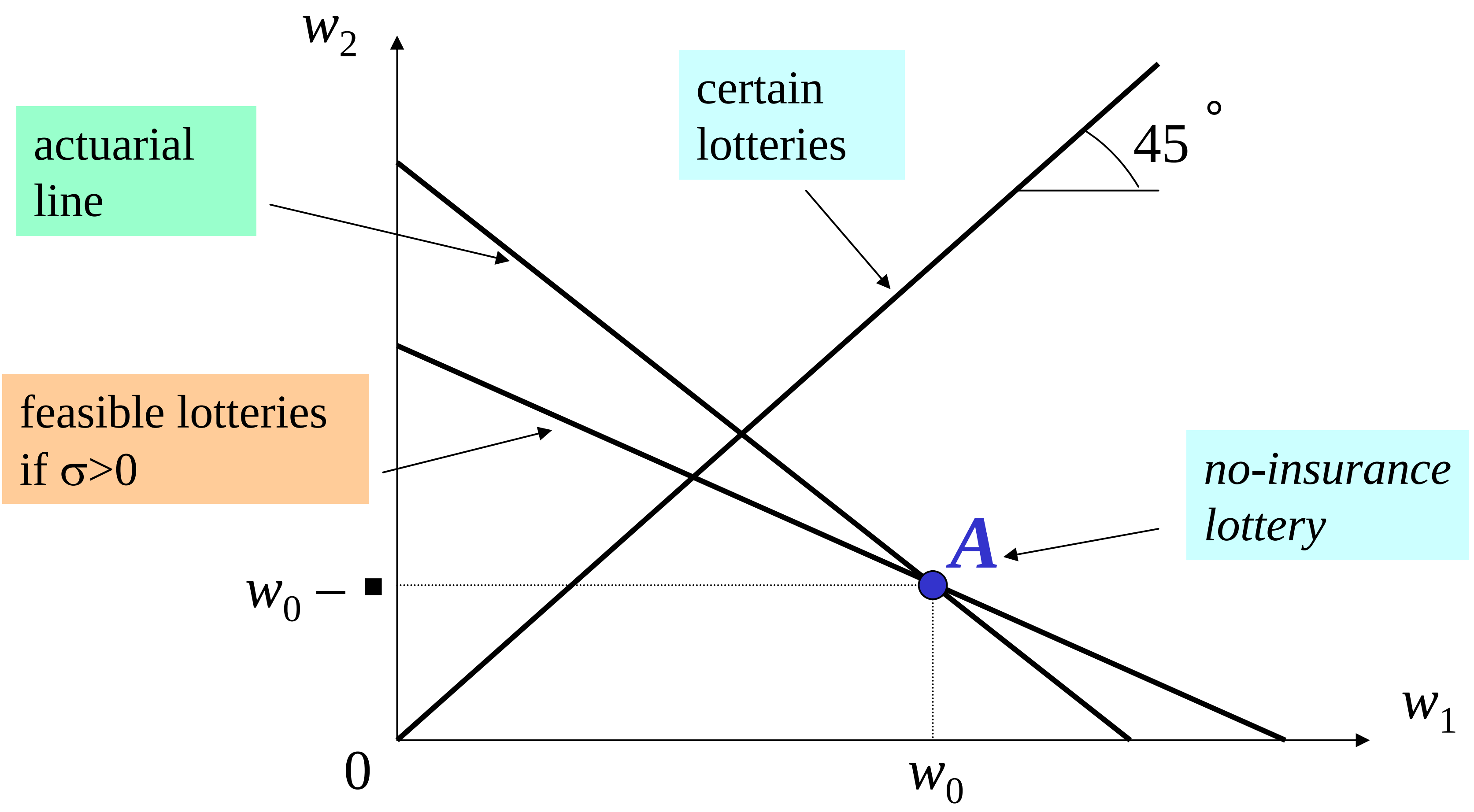
$$w_1 = w_0 - P = w_0 - (1+\sigma)]qt$$

$$w_2 = w_0 - \blacksquare - P + q = w_0 - \blacksquare + [1 - (1+\sigma)q]\, t$$

$$t = (w_0 - w_1) / (1+\sigma)q = (w_2 - w_0 + \blacksquare) / [1 - (1+\sigma)q]$$

$$\Rightarrow \quad [1 - (1+\sigma)q]\, w_1 + (1+\sigma)q\, w_2 = w_0 - (1+\sigma)q \blacksquare$$

If $\sigma = 0 : (1 - q)\, w_1 + q\, w_2 = w_0 - q \blacksquare$ **actuarial line**



w_2
actuarial line
certain lotteries
45 °
feasible lotteries if σ>0
no-insurance lottery
A
$w_0 -$ ■
w_1
0
w_0

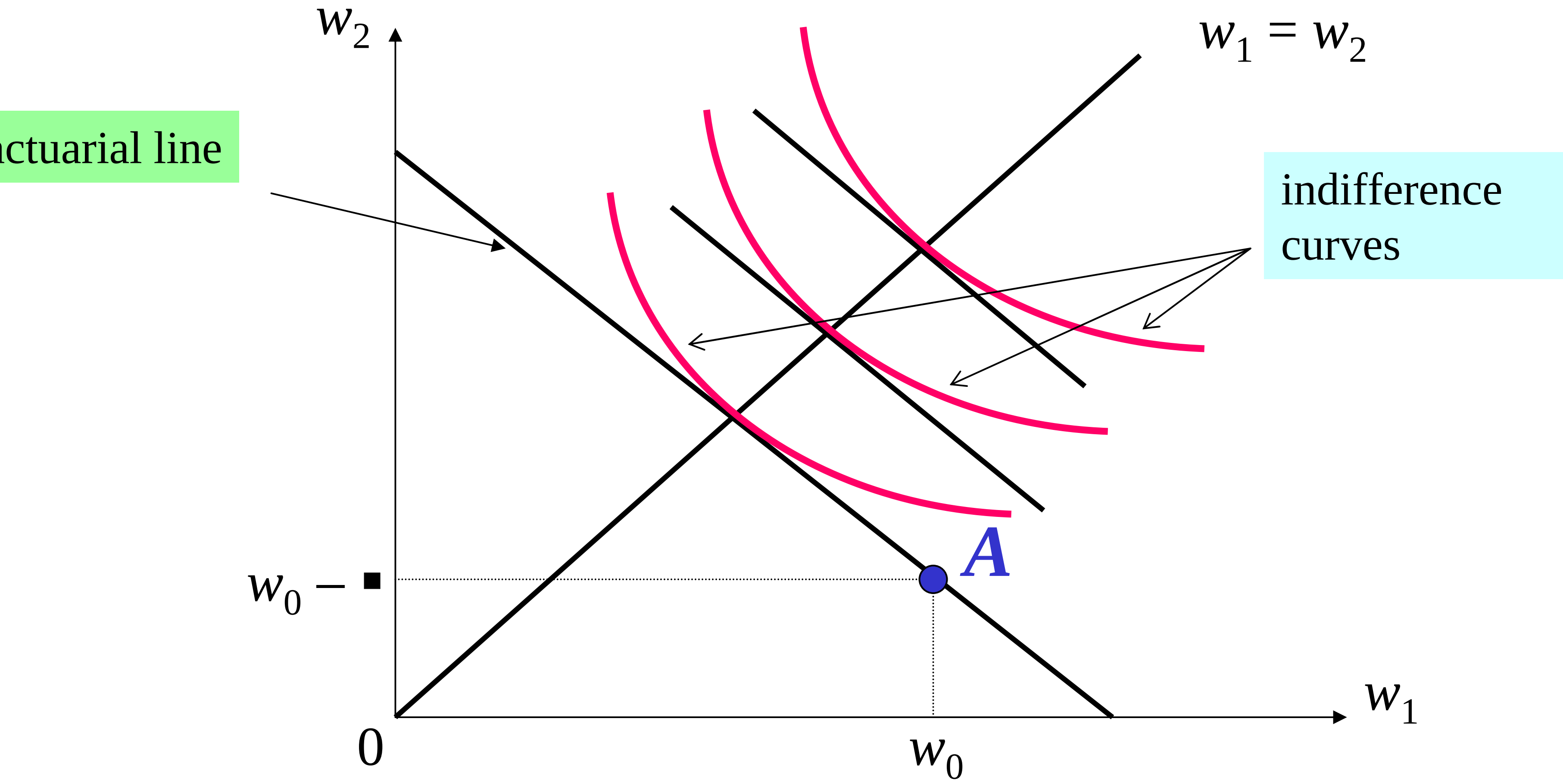
Marginal rate of substitution

The marginal rate of substitution from w_2 to w_1 is $TMS_{12} = \lim \{- \Delta w_2 / \Delta w_1\}$, when $\Delta w_1 \to 0$ et $\mathbf{E}u(w_f)$ is unchanged

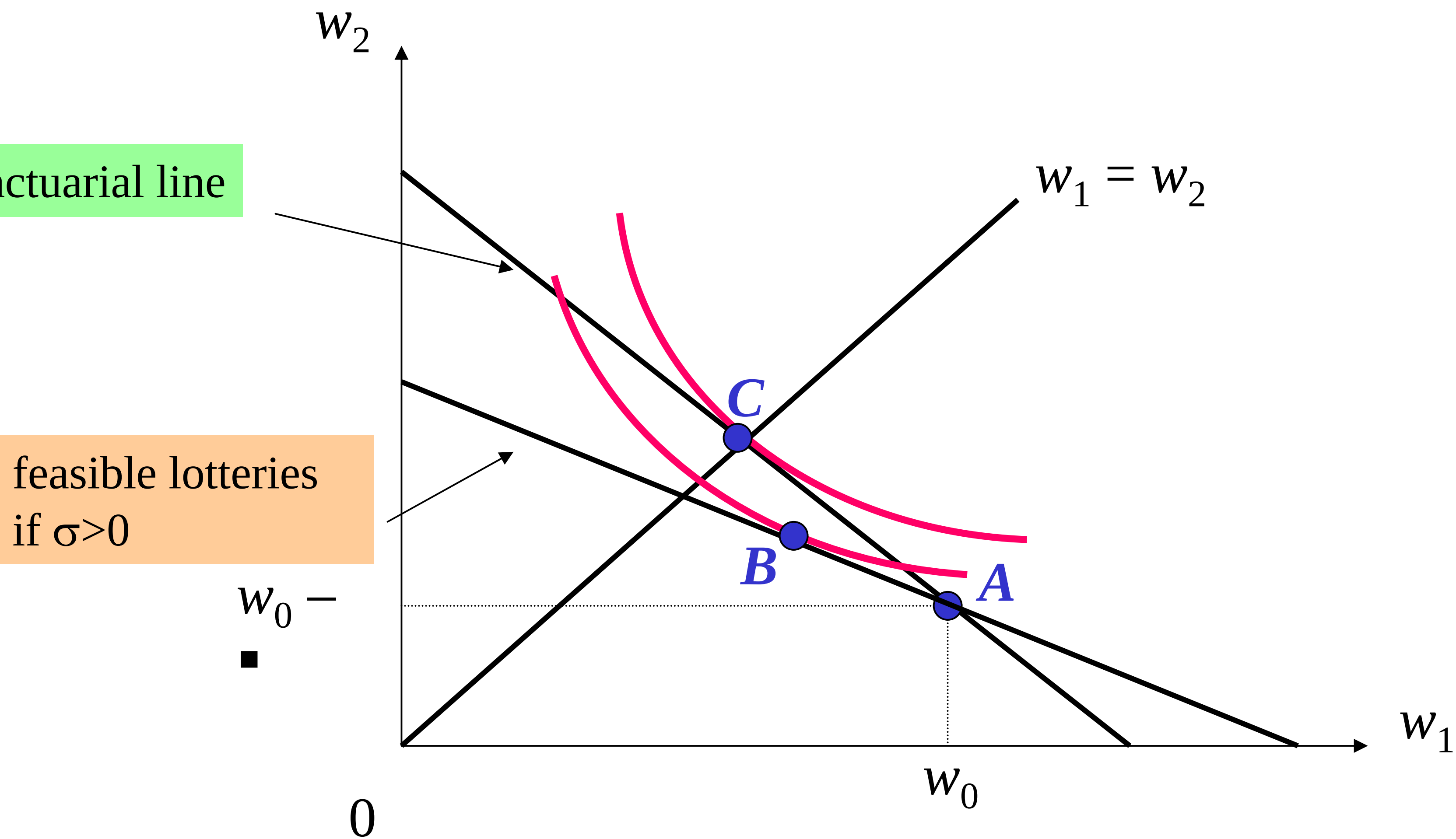
It is the slope (in absolute value) of the indifference curve for a lottery (w_1, w_2).

$$TMS_{12} = (1-q)\, u'(w_1) / q\, u'(w_2)$$

When $w_1 = w_2$ then $TMS_{12} = (1-q) / q$: it is the slope (in absolute value) of the actuarial line.



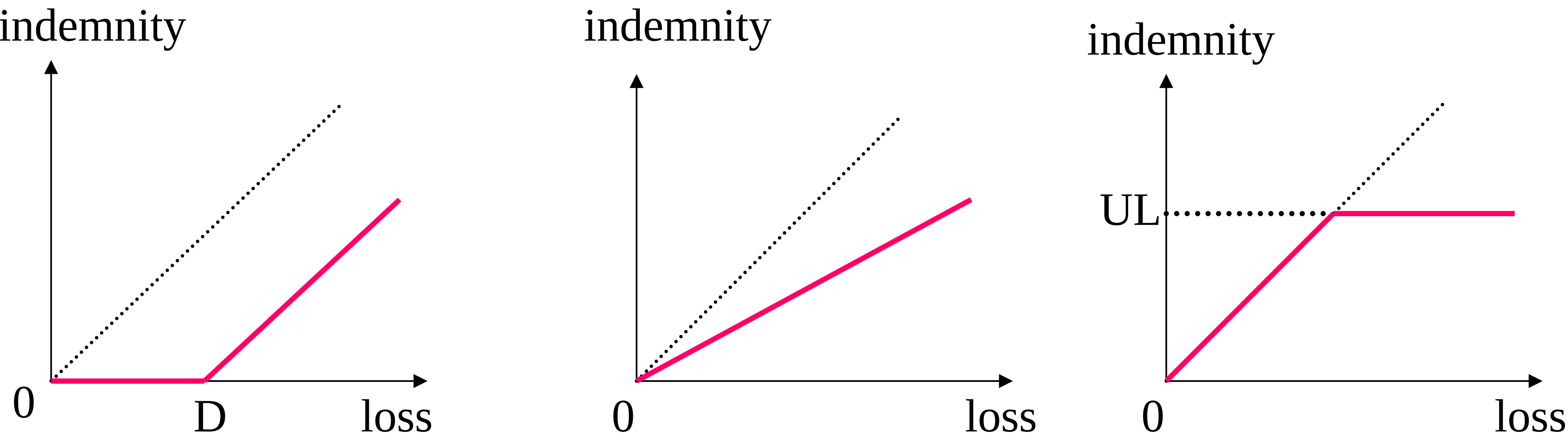
w_2
$w_1 = w_2$
ctuarial line
indifference curves
A
$w_0 - \blacksquare$
0
w_0
w_1



$\sigma = 0 \;\Rightarrow\; w_1 = w_2 \;\Rightarrow\; t = ■ \;\Rightarrow\;$ full coverage

$\sigma > 0 \;\Rightarrow\; w_1 > w_2 \;\Rightarrow\; t < ■ \;\Rightarrow\;$ partial coverage

Indemnity schedule



deductible D

co-payment

upper-limit UL

Examples: car insurance for deductibles, health insurance for co-payments and liability insurance for upper-limits.

Remark 1

What is the optimal indemnity schedule? Arrow (1971) has shown that the optimal indemnity schedule is a straight deductible when the loading factor was constant (i.e. independent from the size of the losses): it maximizes the insured's expected utility when the accident losses are random. However, moral hazard reasons may justify co-payments or upper limit on coverage.

Remark 2

Sometimes individuals prefer full coverage to partial coverage even if there is a positive loading factor. Why? A possible reason is related to the existence of a uninsurable **background risk** positively correlated with the insurable risk. Think of health insurance when illness prevents you from working and income reduction cannot be insured. Think also of fire insurance for a firm, when the costs due to business interruption cannot be fully insured. By purchasing a more complete health insurance, you implicitly cover the correlated income risk. Likewise, fire insurance contributes to smooth the costs of business interruption.

Asymmetric information

For various reasons, there may be asymmetric information between insurers and insureds:

- Hidden information on risk and **adverse selection**
- Hidden preventive action and **moral hazard**
- Hidden information on losses and **claims fraud**.

These asymmetries affect the insurance contracts offered by insurers as well as the features of the competitive equilibrium on the insurance markets.

2. Adverse selection

Akerlof's market for lemons

Suppose that insurers cannot observe the accident probability of a customer. Then the premium reflects the average probability of accident. This may be considered as too costly (unfair) by low risk individuals: they will reduce their insurance demand, and the price of insurance will increase even more! The insurance market will be at an inefficient equilibrium. Examples: think of life insurance or health insurance.

Rothschild-Stiglitz model

- 2 types: $q = q_h$ for high risk individuals,

  $q = q_{\blacksquare}$ for low risk individuals.
- $\lambda \in [0,1]$: proportion of high risk individuals.
- $q^* = \lambda\, q_h + (1 - \lambda)\, q_{\blacksquare}$: average accident probability.
- Insurers cannot observe the risk type: there is an **asymmetry of information**.

Equilibrium of the insurance market under asymmetric information

Definition: An equilibrium of the insurance market is a menu of insurance contracts $(P_1,t_1),\ldots,(P_n,t_n)$ such that:

- Each contract in the menu at least breaks even on average (otherwise, insurers offering that policy would withdraw the policy),
- No contract can be created that, if offered in addition to those in the menu would make strictly positive profits.

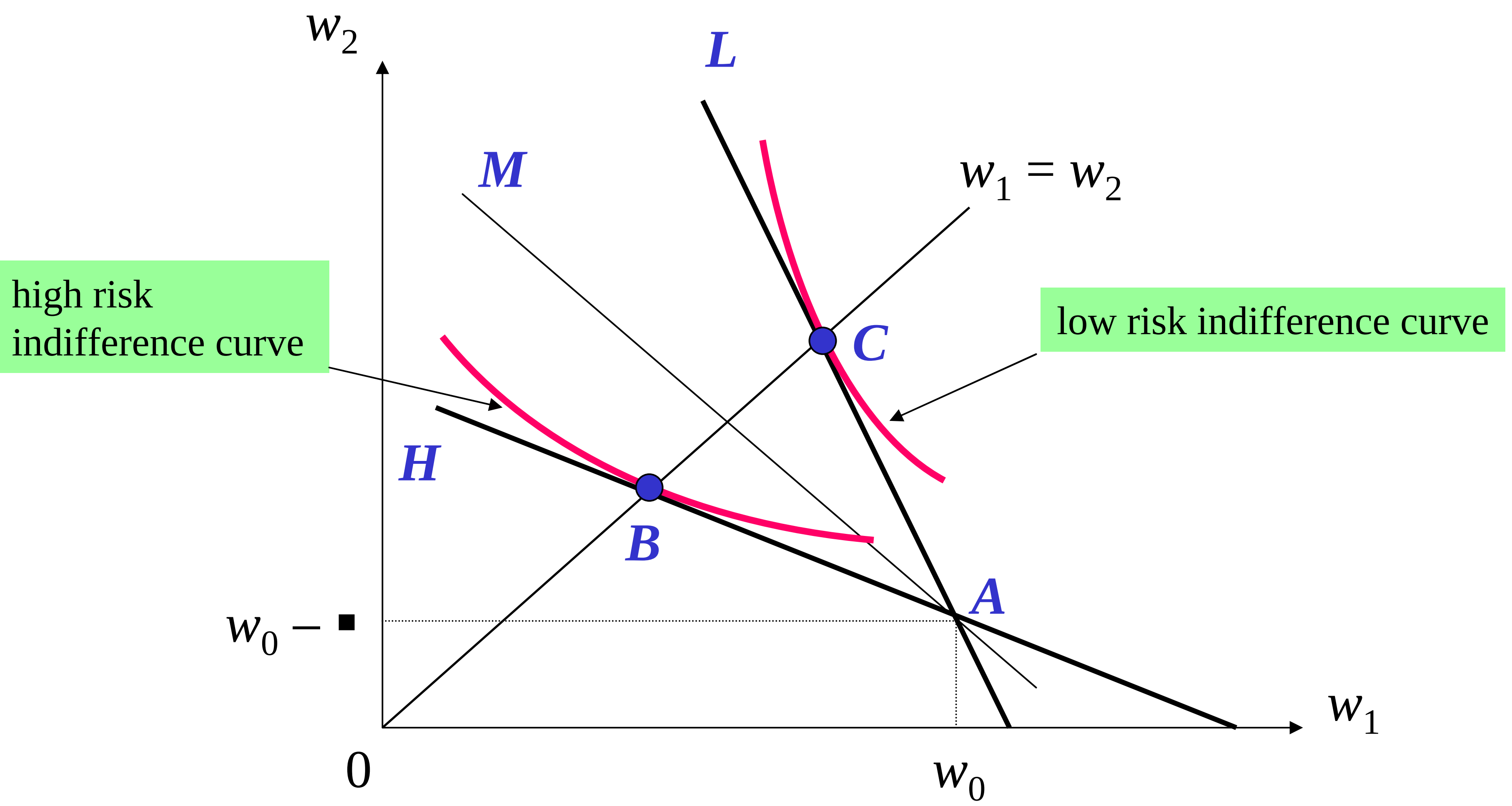
Interpretation: a perfect competitive market with free entry. In a game theory framework: the Rothschild-Stiglitz equilibrium is a subgame perfect equilibrium of a two-stage game: at stage 1, insurers offer contracts and at stage 2, individuals choose one of the contracts.

Pooling equilibrium and separating equilibrium

- Without loss of generality, we may assume $n \leq 2$ (because there are two types: high risk and low risk).

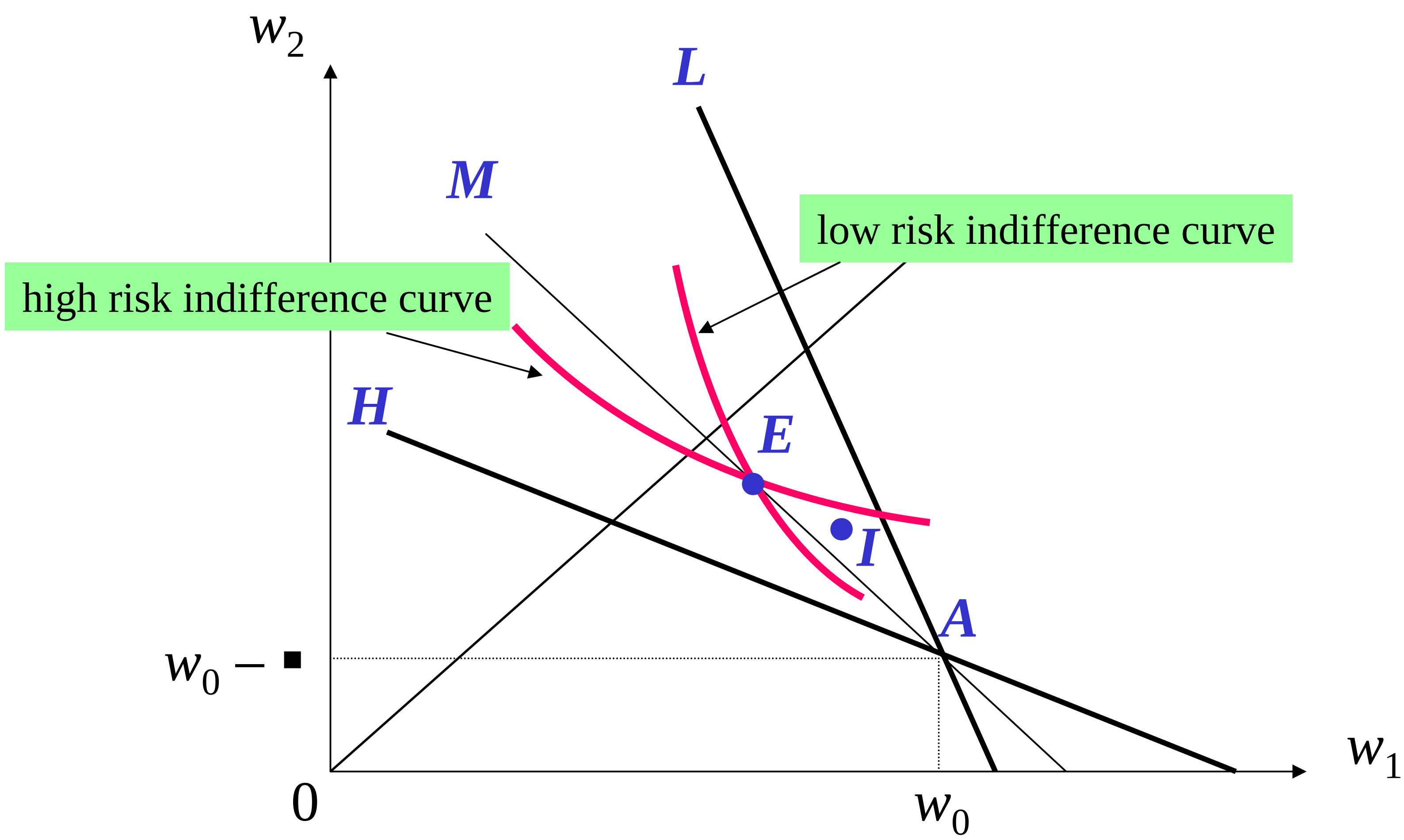
- When high risk individuals and low risk individuals choose the same contract (i.e. $n = 1$), the equilibrium is **pooling**.

- When high risk individuals and low risk individuals choose different contracts, the equilibrium is **separating** ($n = 2$).

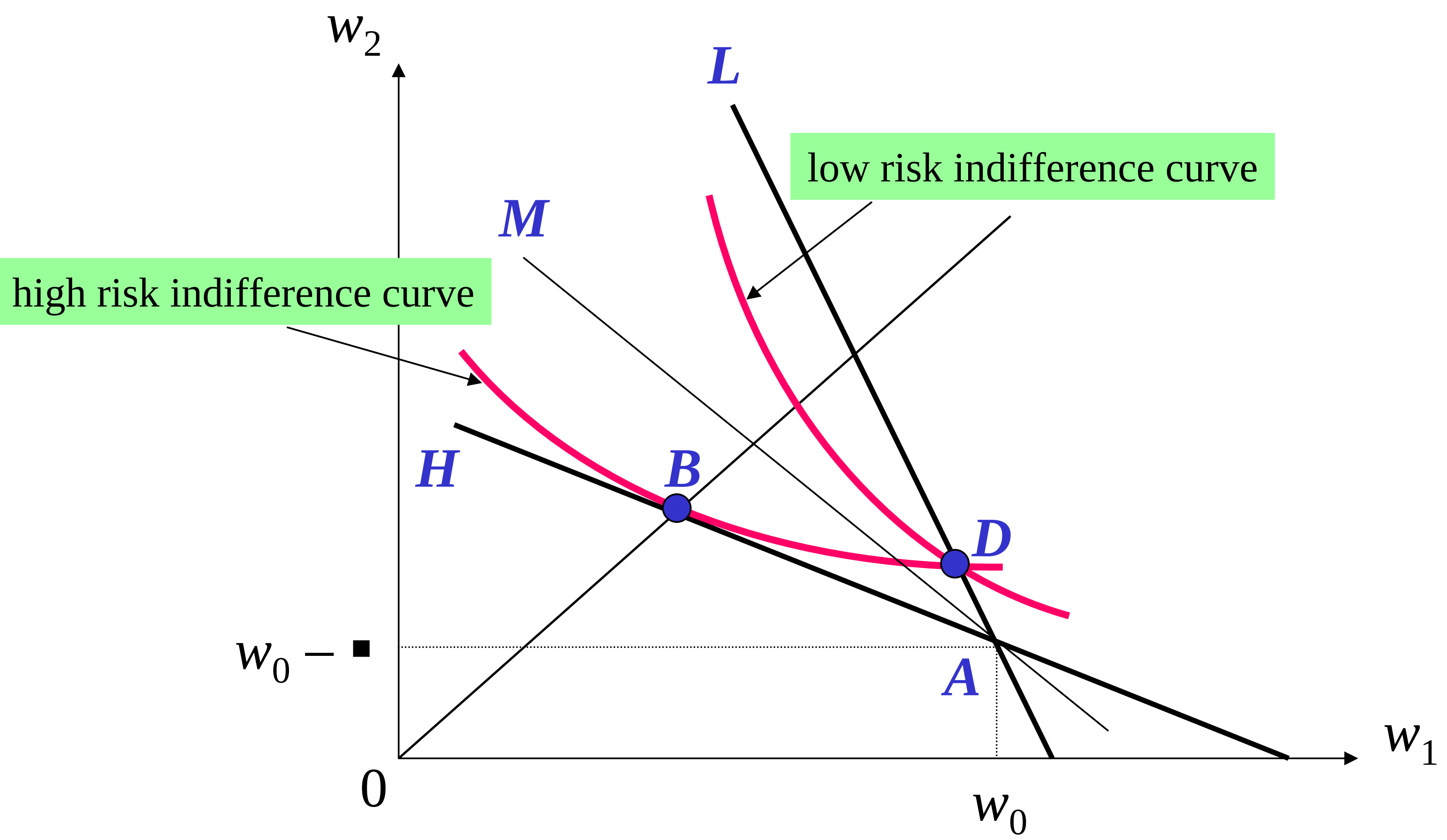


AH = high risk actuarial line, ***AL*** = low risk actuarial line

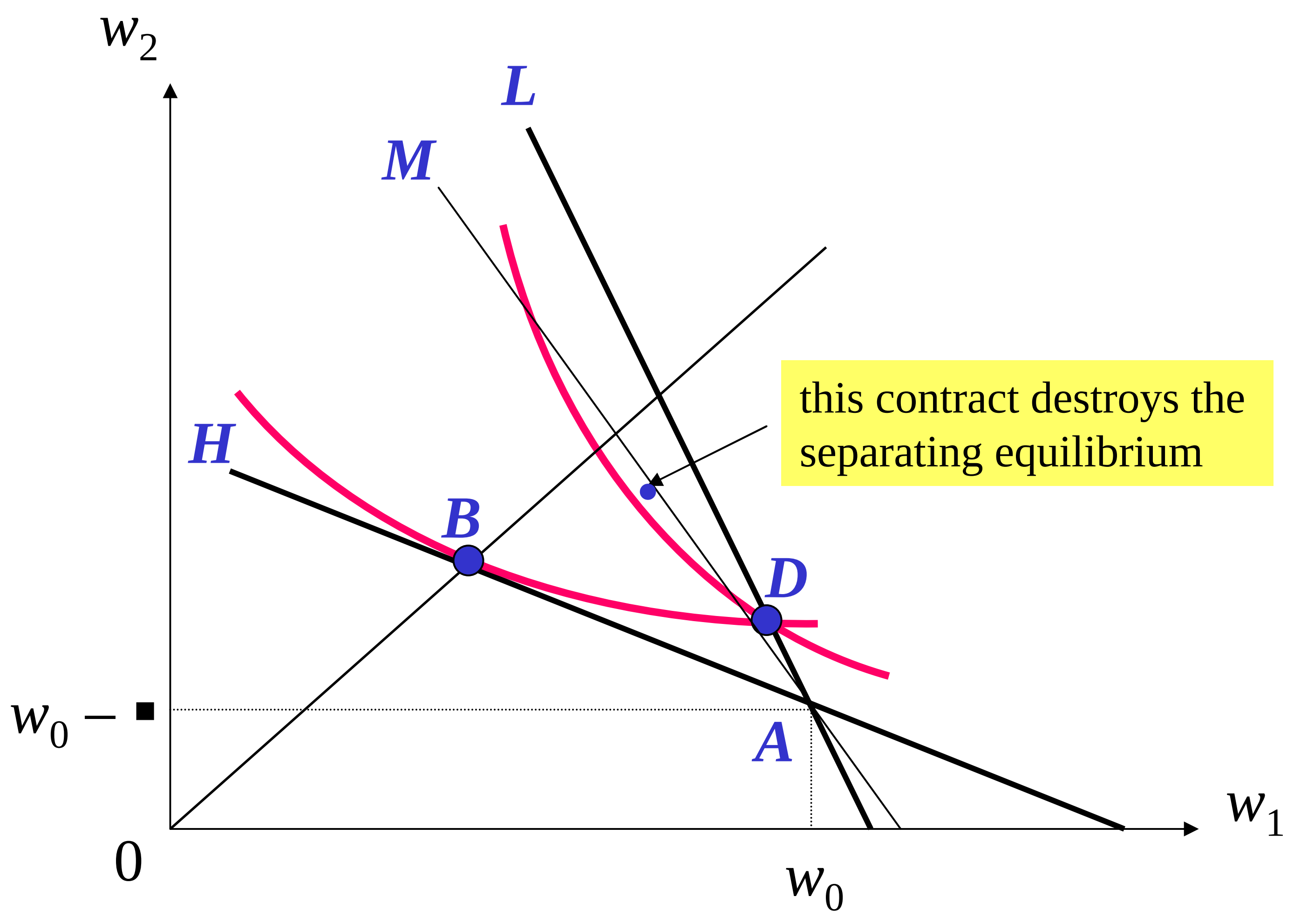
AM = average actuarial line (with probability of accident q^*)



Destroying a pooling equilibrium



A **separating equilibrium**: high risk individuals choose ***B*** (a full insurance contract) and low risk individuals choose ***D*** (a partial insurance contract).



No equilibrium at all

Conclusions from the Rothschild-Stiglitz model

- The equilibrium (when it exists) is separating: low risk individuals take less insurance because of adverse selection. Asymmetric information entails a **welfare loss**.

- This may justify the fact that, according to the law of insurance contracts, insured have a **duty of goof faith**. If, once a loss has occurred, an insurer can prove that the insured has deliberately misrepresented his (or her) risks, the insurer can void the contract. This contributes to a more efficient risk separation.

- **The equilibrium may not exist** : you may check that the equilibrium exists if λ (the proportion of high risk individuals) is large enough. Maybe another concept of equilibrium should be chosen? or another model?

3. Moral hazard

- The risk type depends on the preventive effort level of the individual. He (she) may choose an effort level $e = 1$ or $e = 0$. When $e = 1$, then $q = q_{\blacksquare}$ and utility is $u(w_f) - c$, where c is the disutility of effort. When $e = 0$, then $q = q_h$ and utility is $u(w_f)$.

  In words, the individual can be a low risk by making a preventive effort, but he (she) dislikes effort.

- The insurer cannot observe the effort of the individual: the insurance contract should provide incentives to effort, i.e. the individual should be incited to choose $e = 1$.

Contrainte d'incitation

The individual chooses to make effort if

$$(1 - q_{\blacksquare})\, u(w_1) + q_{\blacksquare}\, u(w_2) - c \geq (1 - q_h)\, u(w_1) + q_h\, u(w_2)$$

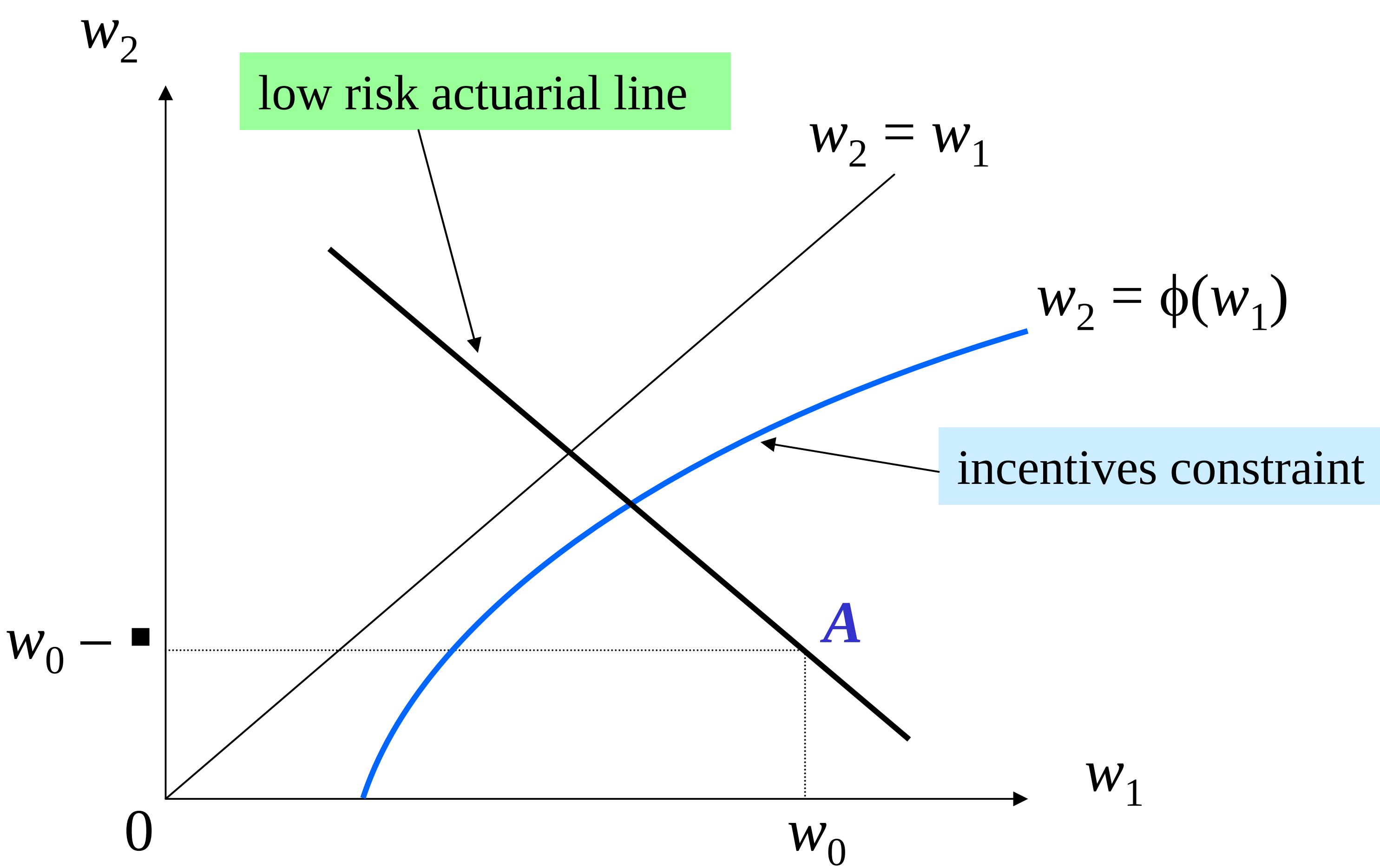
or equivalently if

$$(q_h - q_{\blacksquare})\, [u(w_1) - u(w_2)] \geq c$$

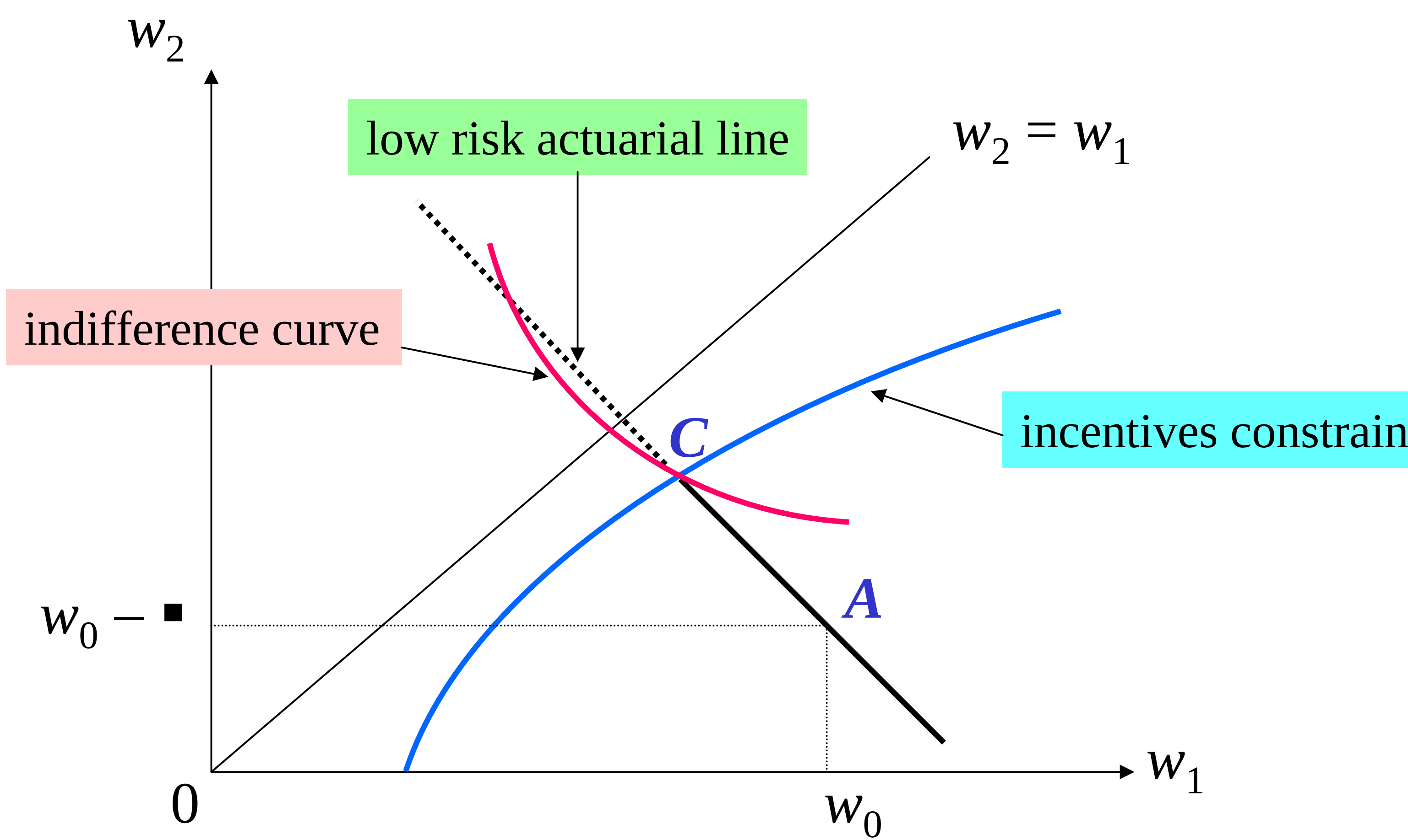
The difference between the utility in the non accident state and the utility in the accident state must be large enough for the individual to be incited to make effort.

The incentives constraint may be rewritten as

$$w_2 \geq u^{-1}[u(w_1) - c / (q_h - q_{■})] \equiv \phi(w_1) \quad \text{with } \phi' > 0 \text{ and } \phi(w_1) < w_1$$

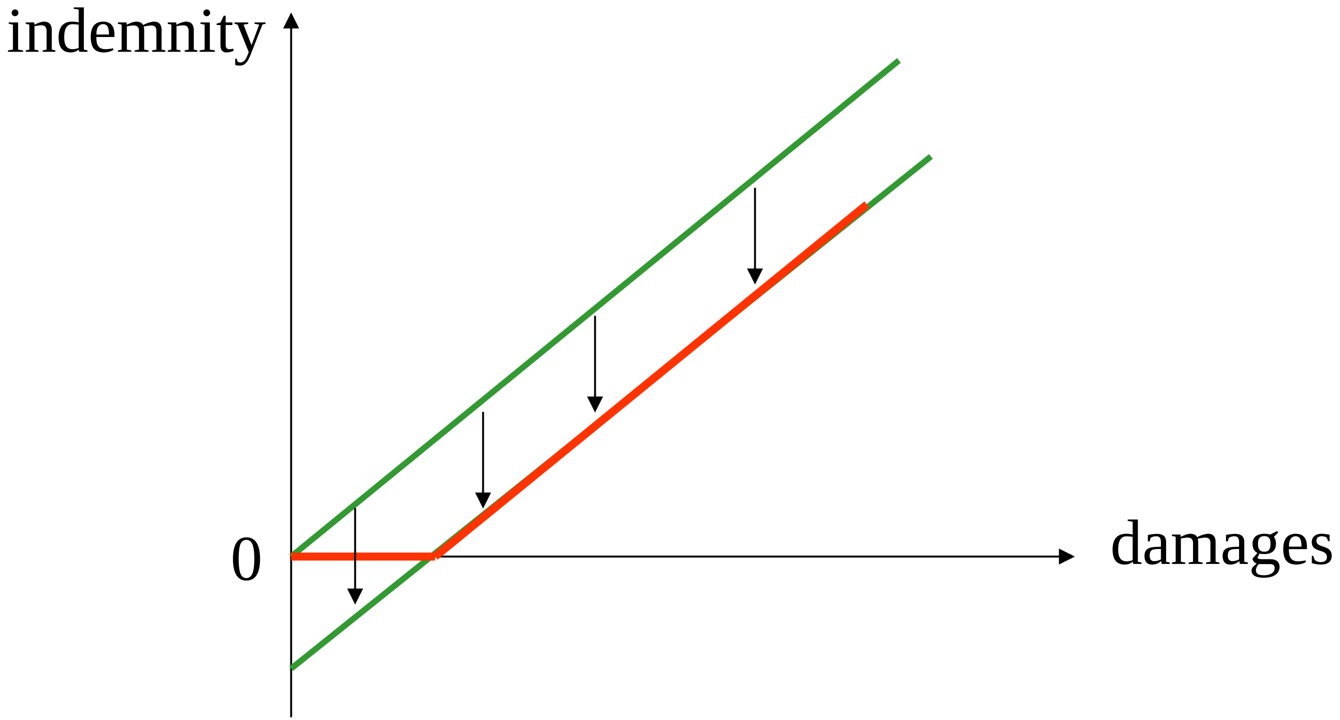


The optimal contract $\boldsymbol{C}$ maximizes expected utility over the low risk actuarial line subject to the incentives constraint. It involves partial insurance: $w_2 < w_1$ or $t < $ ■. There is a trade-off between insurance and incentives.

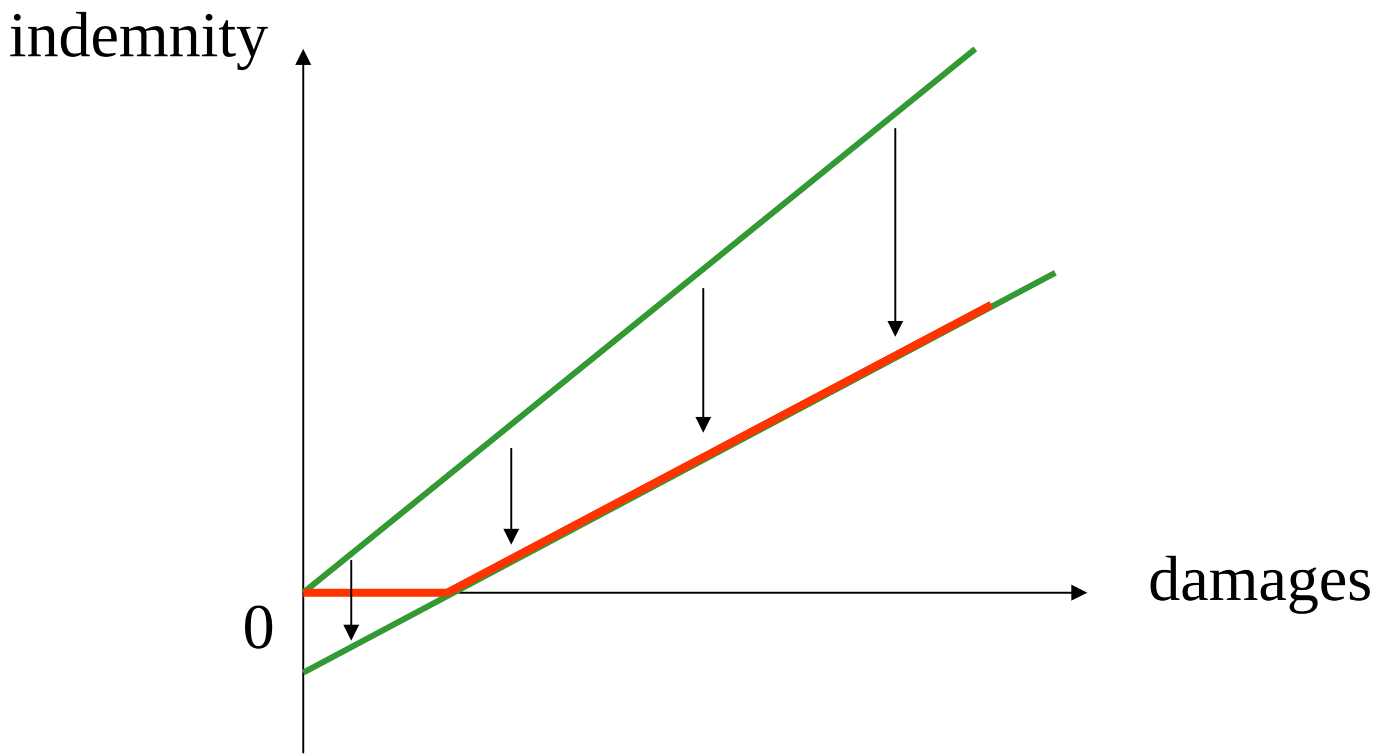


Which consequences for the indemnity schedule?

Straight deductible contracts are optimal when effort affects the probability of an accident but not the (conditional) probability distribution of damages in case of an accident.



When effort simultaneously affects the probability of an accident and the (conditional) probability distribution of damages in case of an accident, then the optimal indemnity schedule combines a deductible and a co-payment.



Comment 1

The moral hazard model provides another justification for straight deductible contracts, but you may find it not very convincing. For example, driving more carefully (say abiding by the speed limits) reduces the probability of bringing about a road accident, but it also decreases the damages in case of an accident. Combining a deductible and a co-payment is better!

Comment 2

A smaller insurance coverage (say a larger deductible) gives more incentives to effort and decreases the risk. We thus obtain a conclusion similar to what we have got from the Rothschild-Stiglitz model in the adverse selection case: the larger the insurance coverage, the larger the risk. There is a **positive correlation between insurance coverage and risk**.

However, **the causality is quite different in both cases**. Under adverse selection, when an individual is in a more risky situation, he purchases more insurance. Under moral hazard, when an individual has a better insurance coverage, he decides to be less careful, and consequently he is more at risk! In practice, it is very difficult to disentangle adverse selection and moral hazard: difficult job for econometricians!

Comments 3

Experience rating is frequent in automobile insurance. It allows insurers to better accommodate themselves to adverse selection and moral hazard. In an adverse selection setting, experience rating works as a learning device: after an accident, the insurer updates his beliefs on the probability that the driver is a low risk or a high risk. Under moral hazard, experience rating provides incentives to careful driving.

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