Selection and Incentive Effects in Health Insurance

Preliminary version

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Abstract

This paper presents empirical results on moral hazard and adverse selection in the demand for medical care.

The data set contains over 40 000 adult individuals covered by a Swiss Health Insurance Fund; annual outpatient and inpatient expenditures are observed for four years, from 1997 to 2000. Switzerland has a standardised optional deductibles health insurance system: each adult individual can choose between five plans, each with a different level of annual deductible. Two characteristics of the system are interesting: individual choice creates room for self selection, and variability in deductible levels (implying different marginal prices of care) may be used to estimate the importance of moral hazard effects.

The data shows strong evidence of selection effects. First, mortality rates are positively related with insurance coverage. Second, a Tobit

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analysis shows a positive correlation between health care expenditures and the level of insurance coverage, for inpatient as well as outpatient care. Assuming inpatient expenditures are not sensitive to prices (the elasticity of demand for hospital care is low; moreover, the cost of a single inpatient day almost always exceeds the deductible), this indicates that selection is an important issue. However, selection effects fail to explain the total correlation between outpatient expenditures and insurance coverage: moral hazard also plays an important role.

In order to test for (adverse) selection and incentive (moral hazard) effects, we write a theoretical model of joint demand for insurance and medical care. The model provides an estimation of the incentive effects, when selection effects are taken into account.

1   Introduction

This paper presents an empirical analysis of the links between health insurance coverage and the level of health care expenditures. Standard insurance theory predicts that expenditures and coverage should be positively correlated, for two main reasons. First, individuals who expect high health care costs may choose a more extensive coverage (*selection effect*)[1]. Second, a more extensive coverage may increase health costs (*incentive effect*), either through an increase in the probability to experience sickness (ex ante moral hazard) or through an increase in expenditures for a given health status (ex post moral hazard).

Even if these two explanations revert the causality relationship between costs and coverage, they are quite difficult to separate empirically, especially on cross sectional data (see, e.g., Chiappori and Salanié, 2000). However, the implications in terms of regulation policies are quite different. If moral hazard is an important phenomenon, a mandatory reduction of insurance coverage reduces the level of aggregate risk, and may therefore increase efficiency. In contrast, if the correlation is due to selection, reducing coverage (such as, e.g., mandatory minimum deductibles) would simply limit the scope of mutually beneficial contracts without affecting the level of risk, which is clearly inefficient (Chiappori-Durand-Geoffard,1998). On the other side, if selection effects are important, then a competitive market may be subject to adverse selection, which requires an adequate regulation. Moreover, from

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[1]We limit the term of *adverse* selection to the situation in which insurance firms compete in contracts and attempt to selectively attract good risks; this is possible only if there is a selection effect in the sense defined above, but market regulation may prevent adverse selection. This is indeed the case in Switzerland, at least as far as basic health insurance is concerned.

an empirical point of view, if selection is an important phenomenon, then estimates of moral hazard obtained on cross-sectional data are upward biased, since the correlation between expenditures and coverage is captured by the moral hazard effect. However, the empirical evidence of (adverse) selection in insurance markets is weak (Chiappori and Salanié, 2000).

This paper uses administrative longitudinal data from a major Swiss health insurance fund to perform a joint estimation of moral hazard and selection effects. An important point is that the menu of contracts offered to each individual is perfectly known, which gives a way to measure the opportunity cost of the contract chosen by each individual.

The main findings of the paper is that even though incentive effects are important, selection effects are also present, and far from being negligible.

Section 2 presents the Swiss health insurance system, and our data. Section 3 presents a simple way to separate incentive and selection effects, and a first parametric estimation of these two effects. It also presents an analysis of mortality rates that provides a strong evidence of self-selection behaviour. Section 4 develops a formal theoretical model of joint demand for health care and health insurance. The estimation of this structural model provides an estimation of the incentive (moral hazard) effect, controlling for selection.

2   The Swiss health insurance system

2.1   Overall description

The Swiss health insurance system offers interesting features that can be used to test for the presence of asymmetric information. Even if it seems reasonable that, in any system, each individual selects the best contract given his/her preferences and information, adverse selection occurs only when this information is hidden to the insurer, or when it is observed but cannot be used for risk selection and/or contract pricing. This latter case corresponds to the Swiss health insurance system.

In Switzerland, health insurance is a two-tier system. Since 1996, according to the Law on Health Insurance (LAMal), all individuals must subscribe to a mandatory insurance, that covers a defined bundle of health goods and services.

All insurance contracts include: a deductible on yearly expenditures, a co-payment rate of 10% once the deductible level has been reached (and a fixed daily contribution of SFr 10 in case of hospitalisation), and a cap on yearly payments equal to SFr 600 (400 euros) in addition to the deductible.

Private non-for profit insurance firms offer a menu of such contracts, that differ in terms of deductibles and premiums. Since 1998, deductibles can be equal to SFr 230, 400, 600, 1200, or 1500. Premiums vary across insurance funds, but are identical for all risk groups, for a given deductible. In particular, no price discrimination based upon age, gender, or health condition, is allowed. Moreover, the range of premium reductions for individuals who choose a higher deductible rather than the basic one of SFr 230 is also limited by law; the explicit motivation of such a regulation was to implement some redistribution between risk groups, since it was assumed that high risks individuals would rather opt for small deductibles.

In short, the law introduced mandatory deductibles and co-payments to address moral hazard issues, imposed uniform premiums to address selection issues, and regulated premium reductions to implement some form of redistribution explicitly based on adverse selection. Finally, redistribution to some specific groups (low income) took the form of premium subsidies directly paid by the State.

We must precise here that outpatient expenditures are supported entirely by health insurance, but inpatient expenditures are supported one half by health insurance and one half by the cantonal government.

In addition to this mandatory health insurance, individuals may also subscribe to a supplementary insurance, that covers additional goods and services considered to be "comfort" services, such as a single hospital room. The supplementary insurance contract may be subscribed at a different insurance firm than the mandatory one, even though it seems that not many individuals use this option.

A particularly interesting feature of the Swiss system is that, as far as "basic" insurance is concerned, the menu of contracts offered to each individual is the same for every individual. This is an important element. Adverse selection predicts that each individual chooses the best contract, and empirical estimation needs to compare the preferred contract with other alternatives, which determine the opportunity cost [4].

A first question we may ask is why different individuals choose different levels of deductibles. Differences in risk aversion, time preference or cash constraints (the premium being paid in advance) may play a role, but our data does not contain the information needed to analyse these points. We investigate an alternative explanation: different expectations about future expenditures may lead high risk individuals to self-select among plans with more extensive coverage.

2.2   Data

We use administrative data, provided by CSS, one of the largest private insurance firms in Switzerland. For each adult individual covered, we observe the amount of yearly health care expenditures as known by CSS, for individuals living in the Canton de Vaud, the Swiss State that includes the city of Lausanne. The data set contains information on 62 415 individuals, and covers four years (1997 to 2000) which represent 199 019 observations.

It is important to stress out that individuals need to address all health care bills to the insurer if they want to be reimbursed; in some cases (mostly for inpatient care, and for some drugs) the insurer first pays the bill, and then charges the amount due (deductible, co-payment, daily contribution to hospital housing cost) to the insured. Therefore, the bill may be received by the insurer, even before the deductible level has been reached and the individual has an incentive to report an expenditure. This administrative data can reasonably be assumed to be highly reliable (at least above the deductible level) in the sense that they include most actual health care expenditures (and all inpatient care expenditures) for the given population. An other benefit of such data is the number of observations: exhaustive health care expenditures for more than 60 000 individuals followed up for four years is certainly highly valuable information.

Unfortunately, administrative data usually provide few variables (with respect to survey data), and that strongly conditions the econometric analysis. Specifically, the following variables are available in our data set:

- Gender (0 = woman and 1 = man)

- Birthyear

- Annual outpatient costs per insured (including drugs) for 1997 to 2000

- Annual inpatient costs per insured for 1997 to 2000

- Deductible for 1997 to 2000

- Rural or urban area (0 = urban and 1 = rural)

- Subsidised premium in 1997 to 2000

- Disability pension benefit (Yes/No) in 1997 to 2000

- Accident supplemental insurance (for inactive and independent workers)

- Supplementary insurance (CSS standard, alternative medicine, semi-private, private, dental care)

- Death.

As said before, the whole data set contains 62 415 adults. We must insist that our sample is not representative of the Swiss population, or even of the population of the Canton de Vaud. However, concentrating on a specific geographic area may reduce unobserved heterogeneity and increase robustness of results. The descritptive statisics of our work data set are presented in section 3.

As a first outline of the distribution of total health costs, Table 1 shows for four intervals the distribution of total health costs per deductible. The table gives the mean (in current SFr) and the standard deviation of the annual health expenditure and, over four ranges of expenditures, the proportion of observations that fall in this interval.

Table 1: Distribution of health expenditures across deductibe

Annual Health Expenditure	Deductible				
	230	400	600	$\geq$1'200	all
	n=91'831	*n=42'581*	*n=34'090*	*n=30'517*	*n=199'019*
Mean	4'205.95	2'443.83	2'128.21	1'278.03	3'024.08
Std. Deviation	*7'795.21*	*5'467.80*	*4'846.92*	*3'742.65*	*6'475.16*
[0]	12.32	17.21	25.08	43.80	20.38
[> 0; 1'500]	33.46	42.41	39.08	35.53	36.65
[> 1'500; 7'500]	40.00	33.85	30.22	17.27	33.52
[> 7'500]	14.23	6.54	5.61	3.40	9.45

Notice that the proportion of agents with no health expenditures dramatically increases with the deductible level. At the opposite, the proportion of high health expenditures decreases strongly with the deductible. This table shows us a positive correlation between insurance coverage and health expenditure. This positive correlation may be due to incentive or to selection effects, or to both. The rest of the paper provides a way to separate these two effects.

3   Asymmetries of information in health insurance

3.1   A simple theory

The problem may be described in the following manner. Ex ante, the agent observes a parameter θ, that provides some information about her own health risk; she chooses her insurance coverage D among a given menu of contracts (in the Swiss context, D is the deductible). Ex post, her health state h is drawn from a distribution conditional on θ, and revealed to the agent; then some variable x is realised. This endogenous variable x represents some observable component of the risk; for instance, x may denote an index of health care consumption (number of doctor visits or hospital stays, annual inpatient or outpatient expenditures,...), or may denote mortality. The key assumption is that, whereas h is not observable by the insurer, x is observable, and related to h in the following way:

Definition 1 *A random variable x is a signal of bad health if: it is observable; it is negatively related to h, conditionally on D. Formally, if we denote by $(x|D,h)$ the distribution of x conditional on (D,h) and by $\succeq$ first order stochastic dominance, we have : for any D, for any $h' > h$, $(x|D,h) \succeq (x|D,h')$.*

In short, *conditional on the contract*, a worse health h leads to a larger x.

Asymmetries of information are twofold: ex post, h is observed by the agent, but not by the insurance firm; moreover, h is drawn from a distribution which, ex ante, the agent knows better than the firm. To fix the idea, we assume the following:

Assumption 1 *The distributions $(h|\theta)$ are stochastically ranked at the first order: if $\theta > \theta'$, then $(h|\theta) \succeq (h|\theta')$*

In short, a high value of θ indicates a better health state. This assumption generalizes the simple situation where $h = \theta + \varepsilon$, where the distribution of ε is independent of θ.

Asymmetries of information cause well known problems to both parties, but also for the empirical analysis of behavior, since only D and x are observed. A standard problem in empirical contract theory (see, e.g., Chiappori-Salanié (2000)) is that a positive correlation between coverage and risk (as measured by insurance claims) may reveal a direct or a reverse causality (or both) between the two variables.

If x denotes some measure of health care consumption, then different values of D may imply different monetary costs to the decision maker. If these monetary costs play no role, then only the health condition determines the "need" for health care, and in that case there is no incentive effect. Given the institutional framework of the Swiss system, we identify the contract with its deductible D, which may take five values ranging from SFr 230 to SFr 1500. Contracts are naturally ordered from the best to the worst coverage (from the lowest to the highest deductible).

Definition 2 *There is an* incentive effect *on x (usually referred to as "ex post moral hazard") if:*

$$\forall h, D' > D \ \Rightarrow (x|D, h) \succeq (x|D', h). \tag{1}$$

This definition means that a better coverage (a lower deductible D), *conditional on the health status*, leads to higher expenditures (when x denotes health care consumption).

However, differences across conditional distributions $(h|\theta)$ may also reveal that agents who expect higher expenditures also decide, ex ante, to opt for a better coverage. If this is the case, then under Assumption 1, $\theta > \theta'$ will imply that $D \geq D'$. A consequence is that the observation of D brings information about the distribution of h.

Definition 3 *There is a* selection effect *if a higher deductible reveals a better distribution of health state:*

$$D' > D \ \Rightarrow (h|D') \succeq (h|D). \tag{2}$$

Since only D and x are observed, we cannot easily separate the incentive and the selection effects. Typically, what we observe is that a better coverage $D < D'$ is associated with a higher x: $(x|D) \succeq (x|D')$, as shown in Table 2 and Figure 1 above. But this positive association may be due to a selection effect, an incentive effect, or both. The following lemma provides a simple decomposition formula (we denote by $\mu_h(.|D)$ the cumulative distribution function of h, conditional on D):

Lemma 1 *Let $D' > D$ be two contracts, X a real-valued random variable. Then we have that:*

$$E[X|D] - E[X|D'] \ = \ \underbrace{\int_{\tilde{h}} \frac{\partial E}{\partial h}[X|D, \tilde{h}] \left(\mu_h(\tilde{h}|D') - \mu_h(\tilde{h}|D) \right) d\tilde{h}}_{A(D,D')}$$

$$+ \underbrace{\int_{\tilde{h}} \left(E[X|D,\tilde{h}] - E[X|D',\tilde{h}] \right) d\mu_h(\tilde{h}|D')}_{B(D,D')}$$

Moreover, $B(D,D') \geq 0$ if there is an incentive effect on X.

Assume that $X = f(x)$, where x is a signal of bad health, and f a nondecreasing function. Then $A(D,D') \geq 0$ if there is a selection effect.

PROOF: see Appendix.

However, notice that if a common unobserved parameter γ (such as risk aversion) leads both to a better health (through an increase in preventative behavior) and to a higher coverage, a higher D may reveal a lower γ, and will be associated with a lower $(h|D)$. (see Araujo-Moreira).

3.2   First results: strong evidence of selection effects

Many observable variables x signal bad health. Some may be subject to incentive effects (e.g., ambulatory care, which demand is known to be price elastic). But for some other variables, it is reasonable to assume that there is no incentive effect. A first example is mortality: given a health condition h, the deductible level should have no impact on the probability to die, at least in the short run. A second example is large expenditures, often related to severe acute or chronic conditions which *require* costly care; besides, in the Swiss context, changes in D have no marginal incentive effects on expenditures above the maximal cap. A third example is inpatient expenditures: standard results in the empirical literature are that price elasticity of demand for hospital care is close to zero (Newhouse, 1993).

If such variables x show a decrease with D, this reveals that on the lower end of the distribution of h (bad health), there is a selection effect.

At the other end of the distribution (good health), health care consumption is low, and may be null or lie below the deductible D. In these cases, changes in D have no (marginal) incentive effect. This provides a strategy to investigate selection effects on the high end of the distribution of health. However, notice that individuals have no incentive to *report* expenditures as long as their total amount remains below the deductible level. Therefore, underreporting may be more frequent among individuals with higher deductibles, and this may bias our results.

We investigate the existence of selection effects by looking at a random variable for which incentive effects are presumably absent: death. The analysis of mortality risk shows that there is a selection effect, at least in the low

end of the health distribution: individuals who expect to be in bad health tend to choose lower deductibles.

3.2.1   Death and the deductible

An interesting feature our administrative data is its size. Indeed, the follow up of more than 60 000 individuals over four years provides a rare opportunity to study the determinants of the mortality rate. This analysis is usually impossible on survey data, given that the average mortality rate is below 1% per year, and sample sizes are rarely larger than 10 000 individuals.

For this analysis, we select the sub-population of individuals aged between 20 and 64 in 1997, who did not exit the sample except in case of death. This sub-sample contains 25 314 individuals, among whom 360 died during the four years of observation.

Mortality data is highly interesting for our purposes. In presence of selection, individuals with a higher probability to die will tend to select lower deductibles, since health care expenditures are usually very high at the end of life. This is actually what the data shows, in a quite striking way. Table 2 presents the gross number of deaths in 1997 to 2000 for each level of deductibles chosen at the end 1996.

Table 2: Death rates per deductible in 2000

Deductible	n	number of deaths					death rate
		1997	1998	1999	2000	Total	
230	12'362	75	56	58	68	257	2.0790
400	4'195	12	8	11	11	42	1.0012
≥ 600	8'757	12	21	16	12	61	0.6966
Total	25'314	99	85	95	91	360	1.4221

To control for age effects, we estimate a simple logit model. The results are given in table 3. The dependent variable takes the value of 1 if the insured died between 1997 and 2000 and 0 if not. Independent variables X are : gender (reference category is female), age, age squared and deductible in 1997 (reference category: deductible 400).

These results show that the probability to die strongly decrease with the deductible, even after controlling for age. Such a pattern cannot be caused by an incentive effect, since (as Table 1 showed) health care expenditure also decreases with the deductible, and health care consumption does not

Table 3: Probability of death between 1997-2000 (n=25'314)

Variables (X)	Coefficients	Odds Ratio	z
Constant	-7.1000		-6.92
Gender	0.8376	2.3108	7.66
Age	0.0075	1.0076	0.17
Age squared	0.0007	1.0007	1.53
Deductible 230	0.6657	1.9459	3.95
Deductible > 600	-0.3671	0.6927	-1.81

(in general) increase the mortality risk. We interpret these results as a very strong support in favor of the "selection effect" assumption.

3.3   A parametric analysis of selection and incentive effects

3.3.1   Data preparation

The original data set contains 62'415 individuals. In order to obtain reliable results, we exclude some individuals of our work data set. We restrict the empirical analysis to a subsample composed of the following individuals:

- men (in our data, we cannot identify pregnancy costs, which the insurance fully covers by law)

- stayed at the CSS from Jan 1, 1997 until Dec 31, 2000 (this excludes people who died or shifted to another insurance fund)

- kept the same deductible during the whole period

- are older than 25 in 1997 (students younger than 25 face a different menu of premiums)

- are not disability pension beneficiaries in any of the four years (such pensions are based on severe health conditions, and a specific public insurance fund covers health care expenses.

The final data set contains 10 712 individuals observed between 1997 and 2000 (which means 42 848 observations).

3.3.2   Descriptive statistics

Table 4 presents the population descriptive statistics of our work data set. In the empirical analysis, the 42 848 observations for years 1997 to 2000 are considered as independent.

Table 4: Population descritptive statistics

Variables *(n=42'848)*		**Mean**	**Std-dev.**
Age in 1997		52.27	15.45
Oupatient expenditures		2'081.41	3'799.87
Frequency of inpatient costs > 0		0.11	–
Inpatient expenditures (if > 0)	*n=4'877*	8'494.13	10'846.26
Total health costs		3'048.22	6'581.81
Subsidized premium		0.21	–
Percentage of subsidy (if >0)	*n=8'805*	0.84	0.73
Accident insurance		0.46	–
Rural area		0.30	–
Deductible	*230*	0.50	–
	400	0.14	–
	600	0.21	–
	1'200	0.08	–
	1'500	0.07	–
Supplementary insurance	*CSS standard*	0.88	–
	alternative	0.55	–
	semi-private	0.12	–
	private	0.11	–
	dental	0.02	–

3.3.3   Econometric assumptions

The distribution of health care expenditures is specific for three main reasons:

1. The distribution is strongly skewed to the right. A small proportion of individuals accounts for a large part of total health care expenditures, even if we exclude the last year of life. Therefore, we consider the log of expenditures instead of the actual level.

2. Expenditures are highly heterogeneous across individuals: In particular, densities of expenditures for in- and out-patient care are very different in shapes. Therefore, we always split the equation between outpatient (including drugs) and inpatient expenditures.

3. Many individuals have no health care expenditure at all during a year (about 25% in our sample). Therefore, we perform a Tobit estimation.

The insurer observes a positive expenditure only if the insured individual reports it. He may have no incentive to do so as long as the total amount of health care expenditures remains below his deductible level. This may induce an important reporting bias, that we address in the following way. We replace all observed expenditures below a constant threshold of SFr 230 with 0, since the values under this threshold might be errors or accounting correction. We choose to perform outpatient and inpatient estimations with the same threshold in order to avoid some side effects which will influence the comparaison between the two estimations.

The model is the following:

$$y_n^* = \beta' x_n + u_n^o$$

with

$$\left\{ \begin{array}{ll} y_n = y_n^* & \text{if } y_n^* \geq 230 \\ y_n = 0 & \text{otherwise} \end{array} \right.$$

where

y_n : observed health care expenditure
y_n^* : real health care expenditure (latent variable)
x_n : independent variables
u_n^o : error term distributed $N(\mu, \sigma^2)$

It is quite standard in health econometrics to assume that positive expenditures follow a log normal distribution (Jones, 2001). Therefore, the dependant variables are the logarithm of the outpatient and inpatient expenditures.

The Tobit models are estimated by maximum likelihood method. The dummy variables for the levels of deductible are defined in such a way that the corresponding coefficient in the regression represents the *difference* between the deductible level and the one immediately smaller. The t-statistic can thus be read as an equality test between these two coefficients. The constant term corresponds to the lowest deductible (SFr 230).

3.3.4   Results

We first perform unconstrained tobit estimations for the logarithm of the outpatient and inpatient expenditures. We also test if the three deductible coefficients are jointly equal to zero. Table 5 presents the results of the two unconstrained estimations for outpatient and inpatient expenditures, and the likelihood ratio test (LR).

Table 5: Unconstrained Tobit estimations (boundary = ln(230))

	ln(outpatient)		ln(inpatient)	
Independent variables	Coefficient	*t-stat*	Coefficient	*t-stat*
Constant	7.67107	*25.90*	-4.80988	*-3.04*
Age	-0.14242	*-8.20*	0.09981	*1.11*
Squared age	0.00342	*10.58*	-0.00056	*-0.35*
Age at power three	-0.00002	*-10.93*	0.00001	*0.56*
Deductible level				
400	-0.12075	*-4.91*	-0.53973	*-4.13*
600	-0.52420	*-18.94*	-0.11931	*-0.79*
1'200 or 1'500	-1.04687	*-34.61*	-1.11079	*-6.42*
Rural area	-0.19075	*-10.66*	0.12212	*1.33*
Premium subsidy	0.24243	*9.56*	1.75478	*14.49*
Accident insurance	-0.15486	*-7.63*	-0.99631	*-9.06*
Supplementary health insurance				
CSS standard	0.02403	*10.33*	-0.04173	*-3.71*
Alternative medicine	0.00072	*0.48*	0.00360	*0.47*
Semi-private	0.02791	*12.68*	0.04271	*3.74*
Private	0.03559	*15.92*	0.04997	*4.35*
Dental care	0.00707	*1.37*	-0.00647	*-0.22*
Maximum Likelihood	*-64'615.21*		*-23'284.70*	
LR test $\chi_2(3)$		*3'940.08*		*137.50*

Age has a global positive effect on both outpatient and inpatient expenditures. This effect is however more increasing across age for outpatient than for inpatient expenditures.

The dummy coefficients for deductibles show that expenditures decrease when the level of deductible increases. For a given individual, outpatient expenditures would decrease by 12% if the deductible went from SFr 230 to SFr 400, other things held constant. This reduction in expenditures is even larger when we move up the deductible scale. All these changes are significant at a the 5% level, except the change from SFr 400 to SFr 600 for inpatient expenditures.

The effect of living are (ref= urban) shows a different pattern for inpatient care than for outpatient expenditures. Living in a rural area decreases

significantly outpatient expenditures. For inpatient care, the increase in expenditures is not significant.

The coefficient of premium subsidy is intersting since this variable is related to household's income. Low income may also be associated to poor health, and higher health care costs.

An accident insurance must be contracted if the insured is not covered through his job. This include independent workers and inactive insured. We note that this category of people spend less in outpatient and inpatient care.

For outpatient care, supplementary health insurance dummies all have a positive effect on expenditures, which is important for semi-private and private insurance. This effect is not significant for alternative medicine and dental care insurance, but such contract cover some goods and services not covered by the mandatory insurance. It is then interesting to note that people who contract an alternative medicine insurance do not spend less in "normal" care. For inpatient care, the results are similar expect for the CSS standard insurance. But this supplemental insurance is contracted by almost all the sample (88 percent) and this effect can hardly be interpreted.

3.3.5   Selection and incentive effects

We then perform a likelihood ratio test on each estimation against the corresponding constraint model setting the assurance variables coefficients at zero.

The likelihood ratio tests are both highly significant ($p < 0.01$). We can therefore reject the null hypothesis under which the insurance variables play no role in our model, and say with confidence that our data shows a positive correlation between health care costs and insurance coverage.

Assume that there is no incentive effect on outpatient expenditures, either because the price elasticity of hospital care is close to zero, or because a single night spent at the hospital induce a total cost close to the cap on yearly payments (and therefore decrease the marginal monetary cost of care to zero). Then the null assumption should not be rejected only if there is *no* selection effect. The null assumption is strongly rejected (the χ^2 value is 137.50), thus providing an other evidence of adverse selection.

There is no reason to believe that selection effects are different for inpatient and outpatient expenditures (what matters for the individual is the expected total out of pocket payment). Therefore, if the coefficients for the inpatient equation reflects only a selection effect, the coefficients in the outpatient equation should be the same, except if there are incentive effects.

Hence, we perform a constrained tobit estimation for the logarithm of the

outpatient expenditures, setting the coefficients of the deductible as equal
to their value in the unconstrained tobit estimation in the inpatient expen-
ditures equation. The results are shown in Table 6. A likelihood ratio test
on the unconstrained model of outpatient expenditures with a constrained
model containing only a selection effect should show us a potential incentive
effect.

Table 6: Constrained Tobit estimation (boundary = ln(230))

	ln(outpatient)	
Independent variables	Coefficient	*t-stat*
Constant	8.01433	*27.02*
Age	-0.15899	*-9.12*
Squared age	0.00372	*11.49*
Age at power three	-0.00002	*-11.82*
Deductible = 400	-0.53973	
Deductible = 600	-0.11931	
Deductible = 1'200 or 1'500	-1.11079	
Rural area	-0.18229	*-10.14*
Premium subsidy	0.18671	*7.58*
Accident insurance	-0.12370	*-6.18*
Supplementary insurance		
CSS standard	0.02408	*10.31*
Alternative medicine	0.00026	*0.17*
Semi-private	0.02956	*13.53*
Private	0.03545	*15.96*
Dental care	0.00222	*0.43*
Maximum Likelihood	*-64'772.10*	
LR test $\chi_2(3)$		*313.77*

Comparing the results of this estimation with the unconstraint estima-
tion for outpatient expenditures (see Table 5) shows us similar coefficients
except for the constraints one (dummies deductible). The likelihood ratio
test between these two models tells us that there exist a significant difference
in the effect of insurance variables on inpatient and outpatient expenditures.
Under our assumptions, this difference can be imputed to a positive incentive
effect in the outpatient expenditures.

To summarise the results, we find an evidence of selection effects, and
an evidence of incentive effects on outpatient expenditures, assuming that

there is no incentive effect on inpatient expenditures.

4   Structural model

The econometric analysis presented in the previous section showed a first way to separate incentive and selection effects. This section presents an alternative econometric approach, that relies on a structural model of joint demand for health insurance and health care, adapted to the Swiss institutional features.

4.1   Theoretical assumptions

We denote by: x (resp. y) the amount of ambulatory (resp. hospital) care used by the individual, by p_x (resp. p_y) its full monetary price (without insurance). We denote the total monetary cost by $M(x, y) = p_x x + p_y y$.

An insurance contract is characterized by a deductible D, a co-payment rate τ, and a cap on expenditures that we denote by $D + \tau K$. As said above, in Switzerland contracts differ by the deductible level D, but the co-payment rate is identical across contracts ($\tau = 10\%$), as well as the maximal amount of annual out-of-pocket health expenditure beyond the deductible (equal to 600 Sfr., which corresponds to $K = 6000$). We denote the insurance premium by $P(D)$. Insurance contracts only cover monetary costs, and therefore the total monetary co-payment is given by: $\min\{M, D + \tau(M - D), D + \tau K\}$.

Notice that the marginal monetary cost of health care is zero when the total amount of past expenditures exceeds the annual cap; therefore, in order to have a finite demand, we introduce a non monetary price associated with health care consumption. This non monetary cost corresponds, e.g., to travel and time costs. In practice, such costs may be related to the opportunity cost of time and to the distance to the point of service. However, our data does not contain information on those variables. In order to keep the model as simple as possible, we assume that non monetary unit costs are proportional to monetary prices: $k_x = a p_x$ and $k_y = a p_y$, and that they simply add up to monetary costs; naturally, these non monetary costs are not covered by the health insurance contract, and therefore the total co-payment writes:

$$
\begin{aligned}
C(x, y; D) &= \min\{M; D + \tau(M - D); D + \tau K\} + k_x x + k_y y \\
&= \min\{(1 + a)M; (1 - \tau)D + (\tau + a)M; D + \tau K + aM\}.
\end{aligned}
$$

The proportionality assumption implies that the relative price of ambulatory and hospital care is independent of the total expenditure M, making the budget set without kink; the full co-payment rate is $C_x = (t(M) + a)p_x$, where $t(M) \in \{1, \tau, 0\}$, and the relative full price is $\frac{C_x}{C_y} = \frac{\tau(M)p_x + k_x}{\tau(M)p_y + k_y} = \frac{p_x}{p_y}$, which is independent of M).

In addition to health care, an individual can consume a composite good, that we denote by c; we normalise its price to 1. If the individual is in health state h, we assume that his overall utility is given by $u(x, y, c; h)$. His overall income is exogenous, and denoted by W_0.

The timing of the decision problem is the following:

1. (Stage 1) At time 0, the agent privately observes some parameter θ, that gives information about the distribution of health stock h. He chooses his deductible level D among the given menu.

2. (Stage 2) At time 1, the health state h is revealed, and the agent consumes (c, x, y).

At time 1, a consumption (c, x, y) leads to a total cost of $c + C(x, y; D)$, which must be smaller than the available budget $W \equiv W_0 - P(D)$. We adopt a dual approach to the decision problem : we assume that the agent minimizes this total cost, and denote by $e(v, h; D)$ the value of this problem:

$$e(v, h; D) \equiv \min_{c,x,y \mid u(x,y,c;h) \geq v} (c + C(x, y; D)) \tag{3}$$

This dual problem is equivalent to the direct utility maximisation problem, provided that v satisfies the consistency requirement $e(v, h; D) = W$, which defines an implicit function $v(h, W, D)$. Since we do not observe income in our data, we may as well model the associated dual variable, i.e. the reservation utility, as a random variable. Under this approach, at time 0, the agent attempts to minimize his expected overall costs, given that at time 1 he will be in health state h and "need" a utility level v, equal to $v(h, W, D)$; both values are unknown at time 0, but conditional on (W, D), v and h are perfectly correlated. However, when W is not observed, v will have to be treated as a random variable.

Notice that the dual approach offers a convenient way to separate the price and income effects of changes in insurance coverage (Blomqvist, 2000; Manning and Marquis, 2001): the solution to problem (3) is the compensated demand, and therefore changes in D induce pure substitution effects on health care consumption.

At time 0, the agent must choose a deductible level. A simple assumption, in line with the dual approach of Stage 2, is to assume that the agent chooses the deductible level that minimizes the total expected cost, i.e. solves the problem:

$$\min_{D} P(D) + E[e(v, h; D)|\theta]. \tag{4}$$

In this setup, the existence of a selection effect is due to the fact that a higher value of θ (a better health) will lead to the choice of a higher deductible D (a lower coverage).

Notice however that some individuals did not behave according to equation (4). In the years considered (1997 to 2000), premiums displayed a very odd pattern: some contracts were dominated, in the sense that they led to a total payment on health care (insurance premium and out-of-pocket health expenditure $P(D) + C(x, y; D)$) higher than another contract under *any* realisation of (x, y). Figure *** below shows the total payment on health care for the whole range of health care expenditures, for the five contracts under consideration, in year 1999 (the other years show similar patterns). We can easily see that it was *never* optimal to buy a contract with a 230 Sfr deductible, since the 600 or the 1500 deductible led to a lower total expenditure in any situation. However, for individuals who expect a high demand, the difference is very small (Sfr 100 or Sfr 7 per year, respectively), and the computation may be difficult to perform

Nevertheless, the important feature we want to take into account is that the choice of D imposes a trade-off between insurance premium and expected expenditures. The premium decreases with D, and out-of-pocket payments increase (in the sense that the conditional distributions of out-of-pocket payments are ranked in terms of first order stochastic dominance). This trade-off is affected by the health state θ since for individuals in *good* health (a higher θ), increases in D induce a *smaller* increase in out-of-pocket payments. This implies a selection effect: observing a higher value of D (a lower coverage) reveals a higher value of θ (a better health); since the distribution of $(h|\theta)$ increases with θ, Bayes' law implies that $(h|D)$ increases with D.

4.1.1 Stage 2: incentive effect

We solve this model by backward induction, and start with the choice of health care expenditure, given a contract D.

Assumption 2 *We assume that the compensated demand for hospital care y is not sensitive to the price of hospital care. Formally, it is given by a function $Y(h)$ which satisfies the following properties:*

- *for h low enough, $p_y Y(h) > D + K$ for any D;*

- *for h high enough, $Y(h) = 0$.*

The interpretation of this assumption is simple. on one side, individuals in very bad health spend more than Sfr 7 500 per year in hospital care; on the other side, individuals in good health do not consume hospital resources at all.

The following proposition characterises the solution to problem (3).

Proposition 1 *Under Assumption 2, there exist two functions $h^1(v, D)$ and $h^2(v, D)$, both increasing with v and decreasing with D, with $h^2 > h^1$, such that the co-payment rate is determined by the following rule:*

- *If $h < h^1(v, D)$, then health care consumption exceeds the cap: $t^* = 0$;*

- *If $h \in [h^1(v, D); h^2(v, D)]$, then health care consumption is between the deductible and the cap: $t^* = \tau$;*

- *If $h > h^2(v, D)$, then health care consumption is below the deductible: $t^* = 1$.*

The compensated demand for health care $x(v, h, D)$ is the solution to :

$$\min_{x, c \mid u(x, Y(h), c; h) \geq v} [c + p_x(t^* + a)x],$$

which we denote by $X(v, h, t^*)$.

Moreover, the expected expenditure $E[e(v, h; D)|\theta]$ satisfies:

$$\frac{\partial}{\partial D} E[e(v, h, D)|\theta] = \tau P(h \leq h^1(v, D)|\theta) + (1 - \tau)P(h \leq h^2(v, D)|\theta). \quad (5)$$

PROOF: See Appendix.

This proposition states two main results.

First, given D, the copayment rate is determined by the realisation of (v, h). This result may be best understood on the following figure:

INSERT FIGURE 1

Agents in good health do not consume care, whereas patients in very bad health exceed the annual cap. In all other cases, the co-payment rate

at the optimal consumption level depends both on health h (a good health lowers health care consumption and therefore increases t), and on v (higher demands on overall utility may induce health care expenditures, especially for h low enough).

For a given reservation utility level v, when h increases but remains in the same range, demand for health care smoothly decreases: the marginal cost of health care is not changed, but the marginal rate of substitution between health care and consumption decreases. However, at the margin $h = h^1$, when h increases from $h^1 - \varepsilon$ to $h^1 + \varepsilon$, the agent remains on the same indifference curve $u(x, Y(h), c, h) = v$, but the marginal cost of health care jumps from 0 to τ: this price (incentive) effect is a pure *ex post* "moral hazard" effect, which leads to a discontinuous decrease in x, and a discontinuous increase in c. The same holds at the other margin, for $h = h^2$.

The second result, equation (5) gives the effect of a marginal change in D on total expenditures. This equation may be simply rewritten as:

$$\frac{\partial}{\partial D} E[e(v, h, D)|\theta] = P(h \leq h^1(v, D)|\theta) + (1-\tau)P(h \in [h^1(v, D), h^2(v, D)]|\theta).$$

This formula is simple to understand: if the individual knows for sure that (v, h) is such that h lies in $[h^1, h^2]$, then he knows that he will be in the range of marginal co-payment τ; a increase of 1 Sfr in the deductible increases his total expenditure by $(1 - \tau)$ Sfr. The same is true if the individual knows that he will be in the $h \leq h^1$ range: since in that area, expenditures exceed the annual cap, an increase of 1 Sfr. in the deductible corresponds to an identical increase in the total payment.

4.1.2   Stage 1: selection effect

We can now turn to Stage 1, and characterise the optimal deductible.

Proposition 2 *Let $D' > D$. Then D' is preferred to D if and only if θ is large enough.*

PROOF:
Denote by $\Delta e(D', D; \theta)$ the difference in expected out-of-pocket expenditure, for an individual with signal θ, when changing deductible from D to D'. We have that D' is preferred to D if $\Delta e(D', D; \theta) \leq \Delta P(D', D) \equiv P(D) - P(D')$. We also have that:

$$\Delta e(D', D; \theta) \quad = \quad \int_D^{D'} \frac{\partial E}{\partial D}[e(v, h, \delta)|\theta]d\delta$$

$$= \tau \int_D^{D'} P(h \le h^1(v,\delta)|\theta)d\delta + (1-\tau) \int_D^{D'} P(h \le h^2(v,\delta)|\theta)d\delta.$$

Since, by Assumption 1, $(h|\theta')$ dominates $(h|\theta)$ when $\theta' > \theta$, we have that $P(h \le h^1(v,\delta)|\theta)$ decreases with θ for any (v,δ). Therefore, $\Delta e(D',D;\theta)$ also decreases with θ, and $\Delta e(D',D;\theta) \le \Delta P$ for θ large enough.

■

All other things equal, a higher θ increases the likelihood to be above the cap $(h < h^1)$ or above the cap $(h < h^2)$. Therefore it increases the expected marginal effect of the deductible on out-of-pocket expenditures. When the agent faces the trade off between a premium reduction $(P'(D) < 0)$ and increased out-of-pocket expenditures, a higher θ indicates that contracts with lower deductible levels will be preferable.

4.1.3   Specification

If we now assume Cobb-Douglas preferences on (x,c), such that the utility function is determined by:

$$u(x,y,c;h) = 1_{\{y \ge Y(h)\}} u(h) x^\alpha c^{1-\alpha},$$

where $Y(h)$ is the amount of "necessary" hospital care, $u(.)$ is increasing with h, and $\alpha \in [0,1]$, we can specify the solution to problem (3), i.e. the compensated demand for health care. This is given by the following proposition:

Proposition 3 *Under a Cobb-Douglas specification, the solution to problem (3) is given by:*

- *If $h < h^1(v,D)$, then $x = X(v,h)$;*

- *If $h \in [h^1(v,D); h^2(v,D)]$, then $x = \lambda_\tau X(v,h)$;*

- *If $h > h^2(v,D)$, then $x = \lambda_1 X(v,h)$,*

where $X(v,h)$ increases with v and decreases with h, and:

$$\lambda_1 = \left(\frac{1+a}{a}\right)^{\alpha-1} < \lambda_\tau = \left(\frac{\tau+a}{a}\right)^{\alpha-1} < 1.$$

This proposition states that (ex post) the compensated demand can be written as a "natural demand" $X(v,h)$, that would correspond to the demand for health care if monetary costs were fully insured, multiplied by a reduction factor λ_t that corresponds to the copayment rate.

Proposition 2 can be directly applied, and tells us that the set of all possible values of θ can be split into intervals $[\theta^i, \theta^{i+1}]$ (some of these intervals may be actually void) such that $D^i \in \{230, 400, 600, 1200, 1500\}$ is preferred if and only if $\theta \in [\theta^i, \theta^{i+1}]$. Therefore, observing a deductible level D^i makes it possible to infer that $\theta \in [\theta^i, \theta^{i+1}]$.

Rather than specifying the assumption on the distribution on θ, and the distribution of $X(v, h)$ conditional on θ, the final specification assumption we make is that, conditional on D, the distribution of "natural" expenditures $X(v, h)$, follows a lognormal distribution of parameters (μ_D, σ_D). Formally, this distribution is the convolution of $(X(v, h)|\theta)$ with the distribution of θ, taken over all θ in $[\theta^i, t^{i+1}]$ with $D^i = D$.

Under these specifications, we can now easily interpret the selection and the incentive effect. There is a selection effect if μ_D differs across deductible levels; there is an incentive effect if $\lambda_t < 1$ for $t > 0$.

4.2   Testing for Selection and Incentive effects

The theoretical model provides us with an empirically testable framework. The consumption level x is equal to λX, where X may be interpreted as the consuption level that would prevail in the case of no co-payement. Since $X = x/\lambda$, the three different zones may be represented as:

$$
\begin{aligned}
x \leq D & \Rightarrow X = \frac{x}{\lambda_1} \\
D \leq x \leq D + K & \Rightarrow X = \frac{D}{\lambda_1} + \frac{x - D}{\lambda_\tau} \\
D + K \leq x & \Rightarrow X = \frac{D}{\lambda_1} + \frac{K}{\lambda_\tau} + (x - D - K)
\end{aligned}
$$

Notice that the three zones are delimited only by the observable variable x. Therefore, knowing $x, \lambda_1, \lambda_\tau$ we may compute the level of "natural" health care demand X.

This value X depends of the individual parameters and is highly random.

We first estimated this distribution in a non-parametric setting. The distribution was not significantly different from a log-normal distribution. The main difference was on the left tail, where the empirical distribution was flatter than a log-normal distribution. This fact may be due to the yearly trunkation in the dataset. For very severe conditions, the treatment is more likely to cover more than one year, so that the total cost for curing the desease is underestimated. The precision gains obtained with a parametric

approach may be considered as more that compensating the loss in robustness. Therefore we assume that each individual behave as if it has a natural expenditures level distributed according to a log-normal distribution, with parameters $(\mu_\theta, \sigma_\theta)$.

4.2.1   Estimation method

We impose the setting that the natural level of consumption is distributed according to a log-normal and differs only according to the individual parameters θ. The deductible choice is related to the level of θ, so that $(D|\theta) \succeq (D|\theta') \Leftrightarrow \theta > \theta'$. Using Bayes' law, this relation may be inverted, so that $(\theta|D) \succeq (\theta|D') \Leftrightarrow D > D'$.

We model this by stating that the consumption level, conditional on the deductible level, is distributed according to a log-normal distribution with parameters (μ_D, σ_D).

The estimation method is made through a minimization of the cumulative distance: Knowing λ_1 and λ_τ, we compute X for each x according to the transformation rule described above, then we sort all the observations and compute the cumulative function for each deductible level. We then normalise these cumulative with the level and the scale parameters (which are equal for each deductible level when the no-selection constraint is active). The distance is computed by taking the sum of the square of the distance between the empirical cumulative distribution and the cumulative level from a log-normal $(0,1)$ for all non zero observations. This distance is finally minimized with respect to λ_1 and λ_τ when the incentive constraint is active. Finally, the logLikelihood is computed for each observation, similarly to a Tobit logLikelihood, and summed to provide the logLikelihood of the model.

4.3   Results

We further reduce the data set to increase homogeneity. First we only keep men aged between 25 and 65 in 1997. By doing so, we eliminate some individuals for whom health care consumption increases rapidly with age. Age is from hereon considered as being part of the unknow health status, captured by the θ parameter. Second, subsidies also play a role in the deductible choice, since they affect the trade off between a lower premium cost and lower future out of pocket costs. Hence we exclude all agents who received a subsidy during any year of the sample. This does certainly introduce a biais in the representativeness of the population. Our objective

is not to offer a representative model of the Swiss population, but to test a model for incentive and selection effects.

4.3.1   Benchmark

First, if we assume that no selection and no incentive take place, $\lambda_1 = \lambda_\tau = 1$ and $\mu_D = \mu \forall D$. The mean is equal to 6.27 and the variance is equal to 1.71, while the Loglikelihood is equal to -31783.24. This case is the benchmark for the first two tests.

4.3.2   Incentive alone

This first setting is somewhat bizarre, in light of the previous findings. We assume that no selection does take place ($\mu_D = \mu$) and try to explain the differences in mean consumption only through incentive effects. In short, the λ parameters will capture all the correlation between insurance coverage and expenditures.

   The Distance between the distribution curves is minimized, ending with a $\lambda_1 = 0.169$ and $\lambda_\tau = 0.793$. This implies that until the deductible level is reached, individuals do consume roughly 6 times less than they want to (i.e. what they would consume if their marginal monetary cost was zero). Once the deductible level is reached, they consume about 20% less than they want to, until they reach the cap level. These values seem much too high, in view of standard estimates of price elasticity of demand for care (Newhouse, 1993).

   This intuition is confirmed by the Likelihood level which is lower than that of the benchmark. This rather unusual fact stems from the fact that the estimation is not performed through a Likelihood maximisation, but a distance minimisation. We conclude from this exercice that this model performs poorly.

4.3.3   Selection alone

This setting assumes that indviduals do select the deductible according to they expected level of demand. But, once they chose they contract, they do not take this level into account($\lambda_1 = \lambda_\tau = 1$).

   As expected, the means are decreasing in deductible levels. This means that high risk insured select low deductibles and vice- versa. This setting has a Likelihood of -31849.25 which is 907.62 higher than the benchmark. The Likelihood ratio test against the benchmark is equal to 1815.24, which

Table 7: Selection alone

Deductible (D)	230	400	600	1200	1500
Mean (μ_D)	6.75	6.56	6.09	4.87	3.99
Variance (σ_D^2)	1.55	1.50	1.61	2.12	2.30

Table 8: both effects

Deductible (D)	230	400	600	1200	1500
Mean (μ_D)	6.53	6.48	6.17	5.14	4.31
Variance (σ_D^2)	1.46	1.32	1.37	1.89	2.10

is much higher than the 1% level of a χ^2 with 8 degrees of freedom of 20.1. Once again, there is a strong evidence of selection effect in the sample.

4.3.4 Both effects

Now that we know that some selection is taking place in the sample, we estimate the model without the two constraints. The selection effect shown in the table is slightly less strong than the previous estimation.

The incentive effects are: $\lambda_1 = 0.87$ and $\lambda_\tau = 1.51$ The value for λ_τ is not supported by the theoretical model, since the impact of 10% co-payment may not have a positive impact on consumption. Two factors may explain this surprising result. First the log-normal distribution fails to represent the left tail of the empirical distribution, so that the model "wants" to multiply these values by more than 1. Second, in many cases individuals ignore the true value of the cap, so that this threshold may play a very limited role in the deductible choice and consumption decisions. The λ_1 may well be overestimated due to the high value of λ_τ Roughly, it shows that the demand with full co-payment is equal to one half of the demand with 10% co-payment.

4.3.5 Both effects constrained

Since the value of λ_τ may not be higher than 1, we contraint $\lambda_\tau = 1$. In this case, the estimated value of λ_1 is equal to 0.47. And the selection effect is shown in Table 9. The likelihood is evaluated at -31783.24, giving a likelihhod ratio test of 132.02 against the selection only model. This value is highly significative, the 1% level of χ^2 with one degree of freedom being of 6.63, showing evidence of an incentive effect. Even after taking selection into

Table 9: Both effects constrained

Deductible (D)	230	400	600	1200	1500
Mean (μ_D)	7.06	7.05	6.80	5.85	5.07
Variance (σ_D^2)	1.32	1.18	1.23	1.76	1.97

account, incentive impact are significative, with a reduction of 53% when the co-payment rate increases from 0 to 100%.

Not surprisingly, the selection effect is lower than in the pure selection model, but the mean expenses are still strongly related to the deductible level. One interessting exception is the 230 deductible and the 400 deductible, who seem to be very close in terms of risks, the mean difference in actual costs being mainly explained through the incentive effect.

4.4   Conclusion

Two main conclusions arise from this section. First, the selection effect is very strong. In our data, a naive estimate of incentive effects that would not control for selection effects comes up with absurdly high estimates of moral hazard.

Second, once selection is controlled for, there is still an important incentive effect. An increase in the copayment rate from 0 to 100% decreases the total demand by more than 50%.

5   Conclusion

TO BE COMPLETED

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6   Appendix

6.1   Proof of Lemma 1

By the law of conditional expectations, we have that:

$$
\begin{aligned}
E[X|D] - E[X|D'] &= \int_h E[X|D,h]d\mu_h(h|D) - \int_h E[X|D',h]d\mu_h(h|D') \\
&= \underbrace{\int_h E[X|D,h]d\mu_h(h|D) - \int_h E[X|D,h]d\mu_h(h|D')}_{A} \\
&\quad + \underbrace{\int_h \left(E[X|D,h] - E[X|D',h] \right) d\mu_h(h|D')}_{B}
\end{aligned}
$$

If there is an incentive effect, then $B \geq 0$, since for almost any h, we have that: $\mu_x|D,h \succeq \mu_X|D',h$, which implies in particular that $E[X|D,h] - E[X|D',h] \geq 0$.

Integrating each term of A by part leads to:

$$\int_h E[X|D,h]d\mu_h(h|D') = [E[X|D,h]\mu_h(h|D')]_{\underline{h}}^{\bar{h}} - \int_h \frac{\partial E}{\partial h}[X|D,h]\mu_h(h|D')dh$$

$$= E[X|D,\bar{h}] - \int_h \frac{\partial E}{\partial h}[X|D,h]\mu_h(h|D')dh,$$

since $\mu_h(.|D')$ is the cumulative distribution of h, with $\mu_h(\underline{h}|D') = 0$ and $\mu_h(\bar{h}|D') = 1$ for any D. Similarly, we have that:

$$\int_h E[X|D,h]d\mu_h(h|D) = E[X|D,\bar{h}] - \int_h \frac{\partial E}{\partial h}[X|D,h]\mu_h(h|D)dh.$$

Therefore:

$$A = \int_h \frac{\partial E}{\partial h}[X|D,h](\mu_h(h|D') - \mu_h(h|D))dh.$$

By assumption, if X is, conditionally on D, negatively associated with h, then for any nondecreasing f, $E[f(X)|D,h] \geq E[f(X)|D,h']$, which implies that $\frac{\partial E}{\partial h}[f(x)|D,h] \leq 0$. Finally, if there is a selection effect, then $\mu_h|D' \succeq \mu_h|D$, which means that for any h, $\mu_h(h|D') \leq \mu_h(h|D)$. This implies that $A \geq 0$.

This completes the proof.

∎

6.2   Proof of Proposition 1

We first solve the cost minimization problem for a given marginal co-payment rate t, and then minimize again over all possible values of t. The following lemma

The following lemma provides a way to solve the first step.

Lemma 2 *Denote by*

$$\bar{e}(v,h,t) \equiv p_y(t+a)Y(h) + \min_{x,c|u(x,Y(h),h)+v(c)\geq v} c + p_x(t+a)x,$$

the expenditure function corresponding to variable costs, for a given marginal co-payment rate t, and denote by $\bar{c}(v,h,t)$ and $\bar{x}(v,h,t)$ the associated solution. We have that:

$$e(v,h,F) = \min\{\bar{e}(v,h,1); F(1-\tau) + \bar{e}(v,h,\tau); F + \tau K + \bar{e}(v,h,0)\}.$$

Moreover, $\bar{c}$ increases, and $\bar{x}$ increases, with t. If $U_{cx} \geq 0$, then $\bar{c}$, $\bar{v}$, and $\frac{\partial \bar{e}}{\partial t}$ increase with v. Finally, if u_x decreases with h, then $\frac{\partial \bar{e}}{\partial t}$ decreases with h.

PROOF:

Since $c + C = \min\{(1+a)M; (1-\tau)F + (\tau+a)M; F + \tau K + aM\}$, we have that:

$$
\begin{aligned}
e &= \min_{c,x}(c + C(x, Y(h); F)) \\
&= \min_{c,x}(c + \min\{(1+a)M; (1-\tau)F + (\tau+a)M; F + \tau K + aM\}) \\
&= \min\{\min_{c,x} c + (1+a)M(x, Y(h)); \min_{c,x}(c + (1-\tau)F + (\tau+a)M); \\
&\quad\quad \min_{c,x}(c + F + \tau K + aM)\} \\
&= \min\{\bar{e}(v, h, 1); F(1-\tau) + \bar{e}(v, h, \tau); F + \tau K + \bar{e}(v, h, 0)\}
\end{aligned}
$$

The co-payment rate t determines $p_x(t + a)$, the marginal cost of x with respect to c. Therefore, $\bar{x}$, the compensated (i.e., Hicksian) demand for ambulatory care, decreases with t, and $\bar{c}$ increases with t (pure substitution effect).

If $U_{xc} \geq 0$, it is straightforward to check that both $\bar{c}$ and $\bar{x}$ increase with the reservation utility level v. The marginal expenditure with respect to t is equal to $p_y Y(h) + p_x \bar{x}(v, h, t)$; therefore, it also increases with v.

Since $Y' < 0$ (better health reduces inpatient care), it is sufficient to show that $\bar{x}$ decreases with h to show that $\bar{e}_t$ also decreases with h: (better health lowers the marginal effect of an increase in co-payment rate).

We now want to characterize the values of (v, h, F) such that the solution to problem (3) corresponds to each value of t. Denote by $\phi^2(v, h, F) \equiv \bar{e}(v, h, 1) - F(1-\tau) - \bar{e}(v, h, \tau)$. The Lemma gave conditions under which $\bar{e}_{ht} < 0$; hence we have that $\bar{e}_h(v, h, 1) < \bar{e}_h(v, h, \tau)$: ϕ^2 decreases with h. We also have that:

$$
\begin{aligned}
\phi^2(v, h, F) &= \bar{e}(v, h, 1) - F(1-\tau) - \bar{e}(v, h, \tau) \\
&= p_y Y(h)[(1+a) - (\tau+a)] - F(1-\tau) \\
&\quad + \left[\min_{c,x}(c + p_x(1+a)x) - \min_{c,x}(c + p_x(\tau+a)x)\right] \\
&= (p_y Y(h) - F)(1-\tau) + \left[\min_{c,x}(c + p_x(1+a)x) - \min_{c,x}(c + p_x(\tau+a)x)\right]
\end{aligned}
$$

The second term is always positive; under the first part of assumption **??**, the first term, $(p_y Y(h) - F)(1-\tau)$, is positive for low enough values of h. Therefore, if $h \leq \underline{h}$, $\phi^2(v, h, F) > 0$. Symmetrically, for high enough values of h, the demand for medical care x is zero, and we have that $\phi^2(v, h, F) = -F(1-\tau) < 0$. Therefore, for any value of (v, F), there exists a critical

value $h^2(v, F)$, defined by $\phi^2(v, h^2(v, F), F) = 0$, such that $\phi^2(v, h, F) > 0$ if and only if $h < h^2(v, F)$.

The same can be done with $\phi^1(v, h, F) \equiv F(1 - \tau) + \bar{e}(v, h, \tau) - F - \tau K - \bar{e}(v, h, 0)$.

We also have that:

$$
\begin{aligned}
E[e(v, h, D)|\theta] &= \int_h \int_v e(v, h, D)g(v, h|\theta)dv \\
&= \int_h \left[\int_{-\infty}^{v^1(h,D)} \bar{e}(v, h, 1)g(v, h|\theta)dv \right. \\
&\quad + \int_{v^1(h,D)}^{v^2(h,D)} (\bar{e}(v, h, \tau) + D(1 - \tau))g(v, h|\theta)dv \\
&\quad + \left. \int_{v^2(h,D)}^{+\infty} (\bar{e}(v, h, 0) + D + \tau K)g(v, h|\theta)dv \right] dh.
\end{aligned}
$$

Since function $e(v, h, D)$ is continuous in v, the derivative of $E[e(v, h, D)|\theta]$ with respect to D is simply given by:

$$
\frac{\partial}{\partial D} E[e(v, h, D)|\theta] = \int_h \left[\int_{v^1(h,D)}^{v^2(h,D)} (1 - \tau)g(v, h|\theta)dv + \int_{v^2(h,D)}^{+\infty} g(v, h|\theta)dv \right] dh.
$$

Hence the result.   ■

Contents

Figure 1 : copayment rate in the *(v,h)* plane

characterization: