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Public health insurance and health behavior

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par

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Le doyen

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Contents

Preface

As the popular Sinatra's song "My way" says: And now, the end is near, so I face the final curtain. There has been a long way since my first days as a Ph.D. student. The time has been challenging but full of satisfactions. It has given me the opportunity, not only to improve my knowledge and skills as a researcher, but also to choose three research projects with a great degree of freedom.

I want to say thank you to Professor Alberto Holly, my thesis director, for his advice. I am also grateful to professors Omar Galarraga, Simona Grassi, Brigitte Dormont, Owen O'Donnel, Jürgen Maurer and Michel Mougeot for their valuable comments and help. I want to recognize my colleagues, especially Pierre Stadelmann, Thomas Lufkin and Silvio Daidone. I am grateful for their friendship and for our intellectual exchanges.

I want to express my deep gratitude to my wife, Laia Bosch Gual for making the way towards the end much more enjoyable. I want also to thank my parents, my sister and the rest of my family for their support.

Introduction

Many would agree that health is the most precious good. Preserving health is a demanding task not only for individuals but also for governments. This is reflected in the important amount of resources allocated to health care, which are, in great part, publically financed. In some countries health care expenditure is already above 10 % of the Gross National Product and this share is expected to continue growing at least in the following years. Such trend can be explained by changes in income, financing schemes, technology, demographics and life style.

Motivated to evaluate the impact of a change in a health care financing scheme on demand, I devote the first chapter of this thesis to study how a more generous public health care package can alter health care utilization services. This is a similar question than the one addressed in the The Newhouse report of the RAND's health insurance experiment[29] but in a different context. I examine empirically the gradual expansion of a new public health insurance program named Seguro Popular. The program's gradual expansion serves as an instrument to identify changes in health care demand. The two main results are: First, there is, indeed, a significant change in health care utilization due to insurance; second, individuals with worse health tend to enroll in the public insurance first. The implications of these results may be important as the Seguro Popular is expected to increase the share of the population covered. Using those results, I could predict that the average cost of insuring people could go down since sicker people are already insured but new-comers will change their demand of services as they enroll in the program. This could be taken into account to estimate the funds needed to undertake an increase in coverage.

As a health economist, I am interested in the optimal allocation of scarce resources to maintain and improve the health status of the population. In the second chapter, my colleague Pierre Stadelmann and I developed a theoretical model to analyze the interaction between public and private health insurance providers. We describe a situation where public health care is universally available for free and private health insurance providers offer their service at market competitive prices. We find some evidence that subsidizing the private providers is less costly than treating the individuals that would have stayed in the public sector in the absence of the subsidy. The subsidy eliminates, or at least, reduces the dead-weight-loss associated to a suboptimal treatment for the rich and increases the quality of the services for the poor.

Efforts to preserve health are not only limited to health care expenditure. Appropriate health behavior is an important factor contributing to positive health outcomes. In the third chapter, I study the effect of education on health behavior. Benefiting from an educational reform in Mexico that extended compulsory years of education from 6 to 9 in 1993, I am able to analyze data on health behavior from cohorts before and after the reform. I study sexual behavior and smoking during adolescence. There is a significant preventive effect of education on having an unprotected first sexual intercourse during adolescence. For smoking, I find that increasing education for women beyond the 6^{th} grade increases the probability of beginning smoking during adolescence. This can be interpreted as an emancipation sign of women with higher education yet this does not represent a favorable change in health behavior. Nevertheless, we observe that women have an overall lower propensity of starting smoking than men during adolescence even for educated people.

Chapter 1

Demand for health care and public insurance in Mexico

1.1 Introduction

The Seguro Popular Program (SPS) in Mexico was created in 2001 to protect individuals who were left out of the Social Security System (SSS) against catastrophic health expenditures as well as to improve their access to health care services. Before the implementation of the SPS program, nearly 50 percent of the population did not have access to the SSS, either because they were independent workers or because they worked in the informal sector. The SPS program offers a health care service package to those families that do not have access to the SSS. The SPS enrollment is voluntary in exchange of an enrollment fee that depends on the family's income. The difference in health care utilization between insured and uninsured has been mainly explained in the literature by moral hazard and adverse selection. Adverse selection in an insurance market is regarded as a source of inefficiency since it may destroy the market for low risk individuals. In contrast, adverse selection for public health insurance may not be that problematic given that the government's objective may prioritize insurance among higher risk individuals, even at a higher cost. This is equivalent to redistributing resources from healthier to less healthy individuals. Moral hazard in both public and private health insurance is considered to be a source of inefficiency because the benefit of additional health care consumption does not offset the additional cost. Exceptions are health externalities such as transmittable diseases or very poor individuals for which additional health consumption may lead to a significant improvement in health status. The aim of this research is to identify the source of the difference in utilization between insured and not insured individuals in the SPS program. The identification is particularly interesting, given government's objective to expand the SPS program. In 2005, the SPS covered about 14 percent of the population that was outside the SSS. One objective of the Mexican government is to enlarge the program to cover a bigger share of the population that does not have health insurance through employment. If the difference in health care utilization between insured and uninsured is due to self-selection, then increasing the share of the population covered by a public insurance does not change much the utilization the pattern of new-comers. Consequently, the cost of insuring an additional person is lower than the cost of those already insured. In contrast, if moral hazard is significant, an expansion of the program makes that newly insured individuals change their utilization pattern, thus increasing the total health expenditure. Identifying the source of the utilization difference has a major implication to predict the demand for public health care services and the required investment to provide them. This paper is organized as follows. In section two there is a brief description of the Mexican Health Care System. Section three sets the basis for the analysis between health care demand and health insurance. The model is explained in section four. Section five gives the details for the estimation and section six summarizes the data set. Section seven develops a discussion of the result and I conclude in section eight.

1.2 The Mexican Health Care System

The Mexican Health Care System counts with large public and private sectors. On one hand, the public sector in Mexico is composed by Social Security Institutions (SSI) and a network of Publically Sponsored Health Care Facilities (PSHCF). SSI affiliation is mainly provided through employment and it comes along with other employment benefits. The PSHCF can be accessed through two channels: either through a subsidized fee for service or through affiliation to the Seguro Popular de Salud (SPS). The SPS program requires an annual payment but no fee for service. The private sector is mainly financed by out-of-pocket expenditure because the private insurance market is poorly developed accounting for less than 3 per cent of the total health expenditure. Private health care services are quite heterogeneous; ranging from highly specialized hospitals to low skilled health care givers.

1.2.1 Social Security Institution (SSI)

The Social Security System is fragmented in several institutions which act as health insurance and provide a wide array of health care services and drugs with no co-payment. The Mexican Social Security Institute (IMSS) is the biggest SSI and it is set up to provide health care services to workers in the private sector. It is financed by employer, employee and government quotas. The second largest SSI is the State Workers Social Services and Security Institute (ISSSTE) and it offers health care to public servants. The remaining SSIs, very small in the number of affiliates, were created for specific employees such as those working in the Mexican state-owned oil company and in the army. Each SSI has a network of hospitals which provide health care services exclusively to their affiliates and quality of services varies among institutions. The big share of the Mexican labor force working in the informal sector represents a barrier to SSI to cover more families. Even though most of the employers are requested by law to affiliates their workers in an SSI, only about half of the Mexican population was able access health care through the SSI in 2001. Those families that in 2001 had no affiliation to an SSI mostly had to finance health care to out of pocket expenditure. Only about half of the Mexican population was able access health care through an SSI in 2001. Even though most employers in the private sector are requested by law to enroll their employees to the IMSS, the big share of the informal sector in the Mexican labor market explains why so many families are not affiliated to an SSI.

1.2.2 Seguro Popular de Salud (SPS)

The aim of the SPS program is to provide a form of health insurance to those who are left out of the Social Security System. It was first implemented at the end of 2001 in six states and gradually expanded until January 2005, when it was implemented in the entire country. Enrollment is voluntary and the fee is a function of the family income. For the lowest two income deciles there is a zero enrollee fee, and from the third decile onwards, the fees gradually increase up to a family fee equivalent to 1000 USD per year for the richest. Because most of the family income comes from the informal economy for those affiliated to the SPS program, it is easy for them to understate income in order to pay less The health care services in the SPS program and in the private sector are mutually exclusive. SPS program does not refund health care expenditures but it provides health care for free in its own network of clinics and hospitals. Individuals with high willingness to pay for quality cannot top up the services offered in the SPS program. The higher the quality in the private sector that a family would get given its income with respect to the quality offered in th SPS program, the more likely the family would renounce to the SPS health care benefits even if the SPS services would be provided at no cost.

1.3 Health insurance and health care demand

The interaction between health insurance and health care demand has been deeply analyzed since the early remarks of Arrow(1963) [4] . Empirical research has focused on testing the existence of self-selection and moral hazard. The RAND's health insurance experiment, as it is reported by Newhouse et al. (1993) [29], was a breaking point in the study of health care demand and the impact of insurance on health. The experiment pretended to shed light on two questions: how much more medical care will people use if it is provided free of charge? and what are the consequences for their health? One of the main finding was that cost sharing reduces the amount of health care use of both necessary and unnecessary health care. Further, there is no significant effect on health coming from cost sharing except for the sickest and poorest patients. Cameron et al. (1988) [14] using a count data model for health care utilization describe the interaction between health care demand and insurance choice in Australia. Based on the 1977-78 Australian Health Insurance Survey, they find a significant higher health care consumption in those who were insured with a more generous coverage, but they do not provide a specific percentage for self selection and moral hazard. They point out that the most important explanatory variable in consumption is health status while income becomes the main determinant when choosing an insurance plan. In a subsequent paper, Cameron and Trivedi (1990) [13] combine the 1978-79 Australian Health Survey with the 1983 Australian Health Insurance Survey and thus, encompass two different regimes. They analyze the role of income and health risk in the choice of a health insurance. In the first regime (1977-78) insurance is compulsory and the decision is whether or not to buy a complementary insurance. In the second system (1983), insurance is not compulsory, thus families must decide whether or not to buy insurance at all. This latter case is closer to the Mexican scenario analyzed in this paper. They claim to find evidence against great self-selection beyond gender and age. Regarding Mexican health insurance studies, Zuniga (2008) [37] estimated the simultaneous decision of whether to be self employed and whether to enroll to an SSI. This study benefits from a panel structure of the Mexican Urban Employment Survey (ENEU) 1997-98 and corrects for individual heterogeneity but at the same time is limited due to the lack of health variables. She finds that the most significant factors that explain SSI enrollment are marital status, firm size, age and gender. University degree has an unexpected sign (negative), probably due to a correlation with other variables. Sosa-Rubi et al. (2009) [18] focus on the utilization of obstetrical services in Mexico using the Mexican Health and Nutrition Survey (MHNS 2006). They simultaneously estimate the decisions to subscribe to SPS program and the usage of the services provided by the SPS network. They find significant evidence that women enrolled in the SPS program switched from using the private obstetrical services to an SPS sponsored facility. Barros (2008)[6] combines data from MHNS (2006) and the Mexican Health Survey 2000 to evaluate the impact of the SPS program on health and wealth of the insured population. According to Barros, the SPS program effectively protected families from catastrophic health expenditures, but he cannot find a significant improvement in health status. Probably this is because health care has a delayed effect on health which is difficult to identify within a short time span.

1.4 The model

The eligible population for the SPS program faces a very similar decision problem than a family who has to choose whether to buy a health insurance. Affiliates have to pay an annual health care insurance package. A rational decision would consider the expected value of being insured against its cost. The gains form insurance have to take into account the benefits of a financial insurance and the expected value of health care provision given a certain health status. Now, let us characterize the decision to participate in the SPS program as a two stage utility maximization problem for a typical individual with an income y. The decision is whether or not to be enrolled in a health care network at a price P. Health care affiliation gives the right to receive free health care in the network. Otherwise, health care has to be acquired at price p per unit. The utility function has the following form $U(C, H(e, s|B), D(e, q))$. C represents consumption, H health status and D the disutility (side effects) of getting health care[1]. Health is a function of the amount of health care treatment received e combined with the state of the nature s. B is a vector of socio-economic characteristics. The disutility of health treatment D is a transformation of the amount of health treatment and a provider's quality index named q_i and q_o to refer to the quality inside and outside the network, respectably. The general intuition for modeling the H and D arguments is that patients appreciate the positive impact of health care consumption on their health but at the same time, they hate spending time in queues for a doctor visit.

Second stage

At this stage, the individual has already decided whether to affiliate to a network. If the individual is insured, then he has to solve the following utility maximization problem:

$$\max_{e} U(y - P, H(e, s|B), D(e, q_i)) \quad (1.1)$$

[1]Intuitively D could be interpreted as the amount of leisure to sacrifice in order to get health care treatment. The better the quality, the less leisure that has to be renounced per treatment.

If the individual is not insured, then he faces the following constraint maximization problem:

$$\max_{c,e} U(c, H(e, s|B), D(e, q_o)) \quad st. \;\; y = c - pe \tag{1.2}$$

Let $V_i(y - P, s, q_i)$ and $e_i^*(s, q_i)$ be the indirect utility function and the optimal demand for health care for an individual enrolled in the program. $V_o(y, p, s, q_o)$ and $e_o^*(s, q_i)$ are the respective indirect utility function and the optimal demand for an individual not participating in the SPS program.

First stage

The individual maximizes his expected utility in order to decide whether to subscribe to a health care network. The state of the nature s is unknown at the time of taking the decision but the conditional distribution of the state of the nature is known:

$$\begin{aligned} EV_o &= \int V_o(y, s, p, q_o)\pi(s \mid B)ds \\ EV_i &= \int V_i(y - P, s, p, q_i)\pi(s \mid B)ds \end{aligned} \tag{1.3}$$

w_o and w_1 are the error terms of the expected utility for being unaffiliated and affiliated to a health care network respectively. Then, the probability of being affiliated to a health care network is:

$$\begin{aligned} Pr(\text{affiliation} = 1) &= Pr(EV_1 + w_1 > EV_o + w_o) \\ &= Pr(w_o - w_1 < EV_1 - EV_o) \end{aligned} \tag{1.4}$$

1.5 Econometric specification

The system is described by thee equations, two of them are related to health care utilization and the other to the insurance decision. The three dichotomous endogenous variables are *Ambulatory*, *Hospital* and *SPS* which are defined as:

$$Ambulatory_i = \begin{cases} 1 & \text{if i has used ambulatory services during the past two weeks} \\ 0 & \text{otherwise.} \end{cases}$$

$$Hospital_i = \begin{cases} 1 & \text{if i has been hospitalized during the last year} \\ 0 & \text{otherwise.} \end{cases}$$

$$SPS_i = \begin{cases} 1 & \text{if i is enrolled to the SPS program} \\ 0 & \text{otherwise.} \end{cases}$$

The latent variables are denoted with a star. $\mathbf{X_i}$ represents a vector socio-economic and health variables that are common in the three equations. $\mathbf{Z_{1,i}}, \mathbf{Z_{2,i}}$ and $\mathbf{Z_{3,i}}$ are three vectors variables specific to each equation. The entire system can be described as follows:

$$\begin{aligned} \text{Ambualtory}_i^* &= \alpha_{1,3}\text{SPS}_i + b_1\mathbf{X_i} + c_1\mathbf{Z_{1,i}} + u_{1,i} \\ \text{Hospital}_i^* &= b_2\mathbf{X_i} + c_2\mathbf{Z_{2,i}} + u_{2,i} \\ \text{SPS}_i^* &= \gamma_{3,2}\text{Hospital}_i^* + b_3\mathbf{X_i} + c_3\mathbf{Z_{3,i}} + u_{3,i} \end{aligned}$$

Regarding to the estimation of the system, as it is broadly described by Huguening (2004) [23], it is possible to have both latent and dichotomous version of the endogenous variables as explanatory variables. As the risk of hospitalization is what influences the decision to buy insurance, I use the probability of being hospitalized as explanatory variable for the insurance equation. In contrast, to measure the effect of being insured on the use of ambulatory services I take into account whether an individual is insured, valued 0 or 1. It is the fact, and not the probability, of being insured which makes one more like to visit the doctor. In order to represent the system in a matrix form I name ambulatory use $y_{1,i}$, hospitalization $y_{2,i}$ and enrollment in the SPS program $y_{3,i}$

$$\mathbf{A}^*\mathbf{Y_i^*} = \mathbf{A}\mathbf{Y_i} + B\mathbf{X_i} + C\mathbf{Z_i} + \mathbf{U_i}$$

$\mathbf{A}^*$ and $\mathbf{A}$ define the structure of unobserved endogenous latent variables and the observable dichotomous counterparts respectively.

$$\mathbf{A}^* = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & \gamma_{3,2} & 1 \end{pmatrix} \mathbf{A} = \begin{pmatrix} 0 & 0 & \alpha_{1,3} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

In order to be able to comply with the logical consistency condition as suggested by Gourieroux et al. (1980)[20], I need the resulting reduced form matrix from endogenous variables to be an upper triangular matrix with zeros in the diagonal. Therefore, it is necessary to do some restrictions. For instance, I cannot include ambulatory use as an explanatory variable for the enrollment equation and at the same time enrolment to the SPS program as an explanatory equation for the ambulatory use equation. The proposed model that complies with the logical consistency condition is the following. The first equation takes into account that the propensity for ambulatory use is affected by the fact of being insured. In the second equation, I assume that the propensity of being hospitalized is not affected by insurance status. This restriction may be subject to discussion but it is in line with most part of the empirical studies showing that there is no significant moral hazard effect on hospitalization. In addition to that, induced demand due to insurance it is not likely to occur because in the SPS program physicians are paid a fixed monthly salary. If there is no induced demand and no moral hazard in hospitalization, there should not be any problem with this restriction. In the third equation, I make the assumption that the propensity of being insured is going to be influenced by the propensity of being hospitalized but not by the propensity of using ambulatory services. The reason for this assumption is that hospitalization is the mayor source for catastrophic health care expenditure. Therefore the risk of hospitalization should be a more determinant factor to seek for health care insurance. Now, by computing the reduced form of both matrices, we get:

$$\mathbf{A}^{*-\mathbf{1}}\mathbf{A} = \begin{pmatrix} 0 & 0 & \alpha_{1,3} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Since the resulting matrix has a triangular form with zeros in the diagonal, then it satisfies the condition of logical consistency. The estimation of the system was done using the Geweke-Hajivassiliou-Keane (GHK), the smooth recursive simulator to approximate the integrals of the likelihood function as proposed by Terracol (2002) [34].

1.6 Mexican Health and Nutrition Survey 2006

The 2006 Mexican Health and Nutrition Survey (MHNS) is a cross sectional data set comprehending 206,700 individuals in 48,304 households. It contains information on health status, health insurance and socio-economic variables. Each household having at least one person aged 20 years or more filled in a special questioner on health status, health care utilization and health behavior. The sample analyzed comprehends adults aged 50 years old and older, who were eligible to participate in the SPS program. Considering this group of individuals presents two advantages. First, in this subsample individuals did not have the choice of being insured in an SSI at the time the SPS program was created. Younger individuals may have the choice whether to take an employment offering SSI benefits. Affiliation to an SSI institution usually happens during the first working life years since it is offered as a part of the employment benefits. If a person is offered an affiliation to an SSI, then it is likely that he or she remains affiliated throughout his or her entire career. Secondly, at 50, all women have finished their reproductive life, making it easier to model their health care demand. On the other side I recognize that 50 year old and older adults have higher utilization rates than the general population. So the estimation would be valid only for this group but nevertheless we would have shed some light on individual response to social health insurance. The total sub-sample encompasses 6,306 individuals who were eligible aged 50 or older and who completed

Table 1.1: Explanatory variables means, conditional on health insurance status
Adults years old and older

Variable	SSI	SPS	None	Total
	n=5308	n=1461	n=4845	n=11614
Female	0.556	0.553	0.521	0.541
Age	63.579	62.729	62.653	63.086
Indigenous	0.043	0.106	0.111	0.079
Adults 3	0.446	0.352	0.405	0.417
Minors 3	0.035	0.112	0.083	0.065
Marital status				
Single/divorced*	0.180	0.244	0.263	0.223
Married	0.609	0.558	0.524	0.567
Widowed	0.211	0.198	0.213	0.210
Education				
No education*	0.177	0.434	0.372	0.291
Some education	0.288	0.399	0.340	0.324
Primary	0.264	0.127	0.184	0.213
Secondary	0.135	0.033	0.059	0.090
High school & +	0.136	0.007	0.045	0.082
Income				
Low*	0.119	0.727	0.536	0.370
Medium	0.214	0.132	0.160	0.181
High	0.248	0.049	0.117	0.168
House type	0.419	0.092	0.187	0.281
Health				
Good health	0.513	0.429	0.484	0.490
Good weight	0.476	0.549	0.559	0.520
Chronic illness	0.194	0.194	0.139	0.171
Disability	0.099	0.094	0.082	0.091
Sport	0.236	0.316	0.313	0.278
Smoked	0.318	0.284	0.283	0.299
Alcohol drinker	0.065	0.053	0.076	0.068
Residence				
Rural*	0.118	0.496	0.356	0.265
Sub urban	0.269	0.343	0.314	0.297
Urban	0.613	0.161	0.330	0.438
North	0.140	0.127	0.090	0.118
North Pacific	0.264	0.246	0.172	0.223
Center north	0.192	0.230	0.204	0.202
Center Gulf	0.079	0.128	0.145	0.113
Center South	0.114	0.062	0.106	0.104
South East	0.112	0.172	0.104	0.116
South*	0.099	0.035	0.179	0.124

* Single/divorced, No education, Low income, Rural and South region are the group benchmark categorical variables and for this reason those variables do not appear on the regression tables.

both questioners. The variables conditional sample means on health insurance for explanatory variables are shown in Table 1.1. It also includes information on 5,308 SSI enrolled individuals in a separate column, just for comparative purposes. The list of explanatory variables can be classified in three main groups: socio-economic, health and residence. All variables are dichotomous except *age*. *Adults 3* and *minors 3*, which refer to whether there are three or more adults (older than 19 years old) or minors in the household. Information about marital status, income and place of residence are captured by a group of dichotomous variables. The reference classes for each group (excluded variables) are divorced-single for marital status, low income for income class, rural for type of residence and South region for geographical region. *House type* controls for wealth and takes the value of one if the individual lives in a house with a fixed telephone line, refrigerator and stove. *Good Health* is valued one if the individual considers being in good or very good health. *Sport* equals one if the interviewee regularly does moderate physical activity for more than 30 min two times per week. *Smoke* is valued one if the individual ever smoked more than 20 cigarettes in his/her life. SSI concentrates a larger share of urban, relatively highly educated and high income individuals. In contrast, SPS has a higher proportion of individual living in rural areas (neither suburban nor urban), with low education and low income. The uninsured population has the lowest concentration of individuals with chronic illnesses and disability while it presents a higher concentration of individuals who declare being in good weight. The system of equations is identified by a group of instruments. Health problem is a variable only included in the first equation. This variable has a value of one if the surveyed individual experienced a health problem during the precedent 15 days. In order to break the correlation between ambulatory use and SPS enrollment, I first take the predicted probability of having a health problem given the health status by a probit model and then use the unexplained health shock as an instrument. The variables controlling for the number of doctors per 1000 inhabitants in each municipality are only used in the second equation. These are administrative data published by the National Institute of Statistics Geography and Informatics (INEGI) corresponding to 2005. By identifying the municipalities, it is possible to merge both data sets.

The group of variables that explain enrollment in the SPS program but that are independent of ambulatory use and hospitalization are dummy variables that control for the time when the program became available in each state. In 2001, the SPS program was only implemented in six states. The incorporation of the remaining states occurred gradually until 2005 when the program became available nationwide.

Table 1.2: Instrumental variables means, conditional on endogenous variable value

Instrument	Yes	No	Total
		Ambulatory	
	n=756	n=5550	n=6306
H. problem	0.6428571	0.0998198	0.1649223
		Hospital	
	n=264	n=6042	n=6306
Dr. SSI	1.900173	1.653293	1.663629
Dr. SSA-SPS	0.7624077	0.6662425	0.6702684
Dr. private	0.4713257	0.4448759	0.4459832
		SPS insurance	
	n=1461	n=4845	n=6306
SPS 2002	0.2320329	0.1023736	0.1324136
SPS 2005	0.1341547	0.1973168	0.1826832

SPS eligible population only

1.7 Results and discussion

The estimated parameters are shown in tables 1.3 to 1.6. Tables 1.3 to 1.5 correspond to the estimation of ambulatory use, hospitalization and SPS enrollment, respectively. In these tables, the first column presents the results of the Probit estimation. The second column shows the corresponding marginal effects and column 3 presents the estimated parameters of the simultaneous system. Table 1.6 shows the likelihood ratio and the pseudo R^2 for the equation by equation estimation. In the lower right hand side, the estimated variance covariance parameters are shown. The standard errors are presented in squared brackets at three, two and one star mean one, five and ten percent significance level. In both estimation methods we get the same sign for the coefficients but the magnitude and the significance levels differ. The estimated correlation between the equations' errors is statistically significant especially for equation one.

1.7.1 Ambulatory use

The impact of insurance on ambulatory use is positive and significant even after controlling for simultaneity, with a predicted marginal effect of 3.5 percentage points. Socioeconomic characteristics, except gender, have low explanatory power for ambulatory use. Women are significantly more intense users of ambulatory services with

Table 1.3: Estimation for ambulatory use equation, n=6306

	Probit	Mfx Probit	T. Probit
SPS	0.23[0.056]***	0.0352[0.0093]***	0.315[0.074]***
H problem	1.465[0.051]***	0.205[0.009]***	1.442[0.051]***
Female	0.169[0.058]***	0.0235[0.008]***	0.169[0.058]***
Age	0.022[0.026]	0.003[0.0036]	0.018[0.026]
Age2	-0.129[0.191]	-0.0181[0.03]	-0.106[0.191]
Indigenous	-0.126[0.09]	-0.0164[0.0108]	-0.117[0.09]
Adults 3	-0.062[0.054]	-0.0086[0.0074]	-0.059[0.054]
Minors 3	-0.116[0.093]	-0.0152[0.0113]	-0.116[0.092]
Marital status			
Married	0.047[0.06]	0.0065[0.0084]	0.048[0.06]
Widowed	0.151[0.073]**	0.0226[0.0116]*	0.159[0.073]**
Education			
Some education	-0.108[0.057]*	-0.0147[0.0076]*	-0.101[0.057]*
Primary	-0.034[0.077]	-0.0047[0.0104]	-0.023[0.077]
Secondary	-0.084[0.123]	-0.0111[0.0155]	-0.079[0.124]
High school & +	-0.253[0.168]	-0.0299[0.0163]*	-0.229[0.167]
Income			
Medium	0.085[0.072]	0.0124[0.011]	0.084[0.072]
High	-0.104[0.102]	-0.0137[0.0126]	-0.095[0.101]
House type	0.087[0.072]	0.0127[0.011]	0.088[0.072]
Health			
Good health	-0.301[0.051]***	-0.0418[0.007]***	-0.299[0.051]***
Good weight	-0.144[0.049]***	-0.0204[0.0071]***	-0.141[0.049]***
Chronic illness	0.54[0.059]***	0.0983[0.0132]***	0.532[0.059]***
Disability	0.205[0.08]**	0.0324[0.0141]**	0.205[0.08]**
Sport	-0.109[0.057]*	-0.0148[0.0075]**	-0.111[0.057]*
Smoked	0.071[0.06]	0.0102[0.0088]	0.066[0.06]
Alcohol drinker	-0.399[0.128]***	-0.0434[0.0104]***	-0.412[0.133]***
Residence			
Sub urban	-0.086[0.058]	-0.0117[0.0078]	-0.088[0.058]
Urban	-0.125[0.067]*	-0.0169[0.0088]*	-0.115[0.067]*
North	0.087[0.104]	0.0128[0.016]	0.061[0.105]
North Pacific	0.166[0.09]*	0.0251[0.0146]*	0.142[0.091]
Center North	0.063[0.088]	0.0091[0.013]	0.045[0.088]
Center Gulf	0.218[0.092]**	0.0342[0.016]**	0.203[0.092]**
Center South	0.147[0.107]	0.0224[0.0177]	0.133[0.107]
South East	0.069[0.106]	0.0101[0.0159]	0.033[0.108]
Constant	-2.264[0.874]**	.-	-2.169[0.874]**

1. Age2 coefficient and standard error are multiplied by 1000

an estimated 2.3 percentage points more probability to attend ambulatory services. Age takes a concave form but neither of the variables is statistically significant. *Widowed* have a higher probability of reporting usage of ambulatory services at 5 percent significance level. Education and income do not show any effect. This may be the result of some effects that are canceled out. Regarding education, on one hand, better educated people have a greater ability to avoid unnecessary doctor visits. On the other, education may make individuals aware of the health risk related to untreated illnesses. An explanation of the no effect of income on ambulatory use could be that high income households use more ambulatory services than low income households but they access higher quality services. In addition, for families enrolled in the SPS program there is no co-payment for ambulatory services, making income less relevant to explain utilization. Health variables are, most of them, significant and with the expected sign. *Good weight*, *Good health* and *Sport* variables reduce significantly the probability of visiting a doctor (during the precedent15 days). The instrumental variable health problem is highly significant and any criteria for a weak instrument test ($\chi = 825$). *smokes* has a positive coefficient but it is not statistically significant which may be due to the fact that the variable does not capture if individuals are currently smoking or how intense smokers they are. *Alcohol drinker* has a negative and statistically significant coefficient, showing that alcohol drinkers are more reluctant to use ambulatory services. Geographic variables do not seem to have a major explanatory power in the utilization of ambulatory health services. Only *North Pacific* and *Center Gulf* regions have significant higher use at 10 and 5 percent significant level respectively. Urban individuals are less intense users of ambulatory services at a 10 percent significance level.

1.7.2 Hospitalization

Hospitalization equation shows a very similar pattern than its ambulatory use counterpart. Socioeconomic variables are not significant, not even for gender or marital status. In contrast, health variables are highly significant except for *Good weight* and *smoke* that have the correct sign but do not appear to be significant neither in the equation by equation nor in the simultaneous estimation. *Good health*, *chronic illness*, *disability*, *sport* and *alcohol drinker* variables show the same sign than the previous estimated equation. Geographical location and the municipality's size do not describe in a significant fashion the propensity of having been hospitalized in the last year. Nonetheless, the variables controlling for concentration of doctors working in hospitalization in the municipality are significant and with the correct sign, which is important to identify the system.

Table 1.4: Estimation for hospitalization equation. n=6306

	Probit	Mfx Probit	T. Probit
Dr. SSI	0.046[0.02]**	0.0032[0.0014]**	0.048[0.02]**
Dr. SSA	0.087[0.052]*	0.006[0.0036]*	0.087[0.051]*
Dr. Private	0.336[0.166]**	0.0234[0.0115]**	0.326[0.166]**
Female	0.039[0.07]	0.0027[0.0049]	0.044[0.069]
Age	0.029[0.031]	0.002[0.0022]	0.031[0.031]
Age2	-0.182[0.226]	-0.0126[0.02]	-0.193[0.226]
Indigenous	-0.129[0.116]	-0.0082[0.0067]	-0.117[0.112]
Adults 3	-0.104[0.067]	-0.0071[0.0045]	-0.071[0.068]
Minors 3	0.145[0.108]	0.0112[0.0093]	0.139[0.108]
Marital status			
Married	0.07[0.076]	0.0048[0.0053]	0.072[0.076]
Widowed	0.001[0.093]	0.0001[0.0065]	-0.019[0.094]
Education			
Some education	-0.049[0.071]	-0.0033[0.0048]	-0.052[0.07]
Primary	-0.113[0.099]	-0.0073[0.006]	-0.1[0.097]
Secondary	-0.14[0.158]	-0.0086[0.0086]	-0.144[0.157]
High school & +	-0.004[0.182]	-0.0003[0.0126]	-0.008[0.185]
Income			
Medium	-0.018[0.092]	-0.0013[0.0062]	-0.042[0.096]
High	-0.137[0.122]	-0.0086[0.0069]	-0.166[0.126]
House type	0.061[0.088]	0.0044[0.0066]	0.07[0.088]
Health			
Good health	-0.317[0.066]***	-0.0219[0.0045]***	-0.305[0.066]***
Good weight	-0.025[0.062]	-0.0018[0.0044]	-0.03[0.062]
Chronic illness	0.416[0.07]***	0.0381[0.0081]***	0.424[0.07]***
Disability	0.47[0.085]***	0.047[0.0115]***	0.457[0.085]***
Sport	-0.167[0.075]**	-0.011[0.0046]**	-0.172[0.074]**
Smoked	0.098[0.073]	0.0071[0.0055]	0.092[0.073]
Alcohol drinker	-0.378[0.171]**	-0.0195[0.0062]***	-0.371[0.171]**
Residence			
Sub urban	0.034[0.075]	0.0024[0.0053]	0.034[0.073]
Urban	0.109[0.086]	0.0079[0.0065]	0.091[0.086]
North	0.086[0.134]	0.0064[0.0106]	0.1[0.134]
North Pacific	0.094[0.117]	0.007[0.0091]	0.113[0.118]
Center North	0.129[0.115]	0.0097[0.0092]	0.142[0.116]
Center Gulf	0.277[0.122]**	0.0233[0.0121]*	0.281[0.123]**
Center South	-0.057[0.145]	-0.0038[0.0092]	-0.052[0.147]
South East	0.265[0.132]**	0.0223[0.0132]*	0.296[0.132]**
Cons	-3.265[1.057]***	0	-3.379[1.058]***

1. Age2 coefficient and standard error are multiplied by 1000

Table 1.5: Estimation for SPS enrollment equation. N=6306

	Probit	Mfx Probit	T. Probit
Hospital	0.308[0.088]***	0.0947[0.0296]***	0.368[0.104]***
SPS 2002	0.446[0.058]***	0.1392[0.02]***	0.444[0.058]***
SPS 2005	-0.059[0.054]	-0.0161[0.0145]	-0.061[0.054]
Female	0.124[0.045]***	0.0342[0.0122]***	0.123[0.044]***
Age	0.025[0.021]	0.0069[0.0058]	0.026[0.021]
Age2	-0.222[0.155]	-0.0614[0.04]	-0.23[0.155]
Indigenous	-0.097[0.064]	-0.0259[0.0166]	-0.099[0.064]
Adults 3	-0.104[0.041]**	-0.0284[0.0111]**	-0.108[0.041]***
Minors 3	0.208[0.063]***	0.0616[0.0199]***	0.203[0.063]***
Marital status			
Married	0.125[0.046]***	0.0343[0.0127]***	0.122[0.046]***
Widowed	-0.048[0.059]	-0.013[0.0159]	-0.045[0.059]
Education			
Some education	-0.03[0.043]	-0.0084[0.0118]	-0.031[0.043]
Primary	-0.229[0.061]***	-0.059[0.0146]***	-0.23[0.061]***
Secondary	-0.295[0.1]***	-0.072[0.0213]***	-0.297[0.1]***
High school & +	-0.664[0.167]***	-0.1352[0.0224]***	-0.65[0.165]***
Income			
Medium	-0.139[0.057]**	-0.0367[0.0144]**	-0.134[0.057]**
High	-0.326[0.08]***	-0.0799[0.0171]***	-0.324[0.08]***
House type	-0.267[0.062]***	-0.0681[0.0145]***	-0.268[0.062]***
Health			
Good health	-0.046[0.038]	-0.0128[0.0106]	-0.048[0.038]
Good weight	-0.05[0.039]	-0.0137[0.0107]	-0.048[0.039]
Chronic illness	0.192[0.051]***	0.056[0.0158]***	0.185[0.051]***
Disability	-0.007[0.069]	-0.0019[0.019]	-0.007[0.069]
Sport	0.013[0.043]	0.0035[0.0118]	0.013[0.043]
Smoked	0.095[0.046]**	0.0268[0.0131]**	0.098[0.046]**
Alcohol drinker	-0.163[0.081]**	-0.0423[0.0197]**	-0.162[0.081]**
Residence			
Sub urban	-0.078[0.044]*	-0.0212[0.0117]*	-0.077[0.043]*
Urban	-0.497[0.053]***	-0.1247[0.0121]***	-0.49[0.053]***
North	1.182[0.091]***	0.4172[0.0335]***	1.172[0.09]***
North Pacific	1.095[0.085]***	0.3687[0.0303]***	1.084[0.084]***
Center North	0.915[0.082]***	0.2994[0.0287]***	0.906[0.081]***
Center Gulf	0.863[0.086]***	0.2899[0.0317]***	0.854[0.085]***
Center South	0.841[0.098]***	0.2872[0.037]***	0.83[0.097]***
South East	1.124[0.09]***	0.3917[0.0334]***	1.113[0.089]***
Cons	-2.178[0.698]***	.-	-2.181[0.699]***

1. Age2 coefficient and standard error are multiplied by 1000

1.7.3 SPS enrollment

Contrary to the utilization equations, most of socioeconomic, municipality's size and geographical variables are highly significant to determine the probability to participate in the SPS program. *Female*, *married*, and household with 3 or more minor variables have a positive impact on the propensity of being affiliated and are statically significant at 1 per cent level. Both higher education and higher income reduce this propensity. This result is not surprising since the enrollee fee is a function of income but at the same time, richer families would be able to get higher quality services in the private sector (rather than those offered in the SPS program). Education is highly correlated with long term income so it may be a reason why it shows a similar pattern. Health variables have the expected sign but few of them are statistically significant. *Chronic illness* and *smoke* have a positive influence on the propensity of being insured at 1 and 5 percent significance level. *Good health* and *Good weight* have a negative coefficient which is expected under the self-selection hypothesis, nevertheless it is not significant. *Alcohol drinker* has a lower probability of being insured showing his lower valuation for acquiring health care services. The endogenous variable Hospitalization is highly significant with an estimated 9.5 percentage points higher probability of being insured in the equation by equation estimation and the coefficient is a bit higher for the simultaneous equation estimation. This result can be interpreted that, at least partially, the difference in health care utilization is due to self- selection. Affiliation to the SPS significantly lowers in urban and sub urban households. Affiliation to SPS program seems to be very sensitive to regions. *North* and *South East* regions have an estimated 41 and 39 percentage point higher probability of being affiliated than the South region. The instrumental variables have the correct sign. Individuals living in the states that first implemented the SPS program had a higher probability of being affiliated to the program and highly significant. *SPS 2005* coefficient predicts a lower probability of being affiliated for the individuals living in states that last implemented the SPS program but it is not statistically significant. A joint test for the significance instruments of this equation at the first stage regression shows the null hypothesis of week instrument is rejected $\chi = 13.91$.

1.7.4 The variance covariance matrix

The null hypothesis that the errors between the three equations are independent is rejected at 1 percent. The higher correlation is among the two health care utilization equations with $\rho_{1,2} = 0.184$ which is as expected. Therefore there is a substantial gain in efficiency when estimating both equations jointly. The correlation between equation 2 and 3, hospitalization and SPS enrollment is not significantly different

Table 1.6: Quality of adjustment and the Variance Covariance matrix

Equation 1		Model	
LR χ^2	1231.33	Wald $\chi^2(99)$	194.13
Prob > $\chi^2(32)$	0.0000	Prob > χ^2	0.0000
Pseudo R^2	0.2662		
		Variance covariance matix	
Equation 2			
LR χ^2	200	$\rho_{1,2}$	0.184[0.044]***
Prob > $\chi^2(33)$	0.0000	$\rho_{1,3}$	-0.058[0.03]**
Pseudo R^2	0.0912	$\rho_{2,3}$	-0.028[0.028]
Equation 3		$H_o : \rho_{1,2} = \rho_{1,3} = \rho_{2,3} = 0$	
LR χ^2	810.64	$\chi^2(3)$	18.66
Prob > $\chi^2(33)$	0.0000	Prob > χ^2	0.0003
Pseudo R^2	0.1187		

form zero at any reasonable confidence level. Finally, a correlation between equation 1 and 3, ambulatory use and SPS enrollment is less than 0.06 but still significant at 5 percent. A Hausman test cannot be performed because the data fails to meet the asymptotic assumption for the test. Alternatively, I use a Walt test for erogeneity which with a $\chi(31)$ value of 15.51 rejects at one percent significance level the hypothesis of no systematic difference in the coefficient estimated from the Probit and trivariate Probit equations.

1.7.5 Limitations

The estimation of the system with ambulatory, hospital and SPS endogenous variables shows evidence that the difference in health care use between insured and uninsured individuals comes from both sources. On one hand, the propensity of being insured increases in anticipation of being hospitalized, which corresponds to the adverse selection argument. On the other hand, we observe that the probability of having visited a physician increases with the fact of being enrolled to the SPS program. Although those results are highly significant they may be sensitive to three factors that I want to acknowledge. First, the exclusion restrictions that were imposed in order to estimate the system limited the model to capture moral hazard on hospitalization. The restrictions are in line with the conclusion on previous studies that find moral hazard in ambulatory use and drugs consumption but not in hospitalization. Second, SSI competing alternative was not considered. The reason was the sample considered, older adults, who did not had the choice whether or not to enroll to an SSI. Usually, the decision to find a job which offers enrollment in a SSI comes during the first working life years. At the time the individuals of the sample accepted their first job the SPS program did not exist. Third, this study is based on a cross-sectional data set which does not allow controlling for individual specific effects. An interesting study would have been to measure the health care behavior for individuals before and after enrollment to the SPS program. Fourth, extrapolation of those results to other segments of the population may be invalid. Although individuals face similar incentives under SPS enrollment, there are specific characteristic of the considered group in terms of the opportunity cost of a doctor visit, overall health status and life time planning horizon. Two possible extensions could be recommended for this article. One would be to include quality differences between networks of health care providers. The main challenge would be to find variables that can measure quality in the SPS network and the equivalent in the private sector given certain family income. The second would be to explore if there is a systematic bias on health status since some individuals could be unaware of certain illness that could be correlated with insurance. If this was the case, uninsured individuals could appear to be healthier than they really are, so the impact of insurance on health care demand could be underestimated.

1.8 Conclusions

The analysis of the impact of the SPS program on health care demand benefits from data collected during the first years of the program's implementation. This was crucial in order to model enrollment to the program independently of being affiliated to a SSI institution. In addition, the fact that the program was implemented in different periods in time throughout the country provides a good instrument to identify health care use equations. Based on the simultaneous equation estimation I find evidence supporting an increase in ambulatory services utilization due to SPS program. At the same time, the program has attracted individuals with a higher probability of being hospitalized. In order to evaluate the benefits of additional health care consumption, it is important to measure its impact on health. For several reasons measuring the impact of insurance on health is very difficult to identify. The effects on health might not be instantaneous, it may be endogenous to health care demand and health insurance and they are sensitive to selection bias. The higher propensity to participate in insurance due to higher risk of requiring hospitalization means that the program would have protected the most vulnerable families from catastrophic health care expenditures, which was one of the program's objectives. One of the major policy implications of this study is related with budget planning for expansion of social health insurance programs. As the SPS program expands to cover a bigger share of the Mexican population, I would expect that the new-comers would be in a better health condition than the individuals already insured. This would require an investment which was lower than proportional to the number of newly insured. Nevertheless, the health care demand of the newly insured individuals would rise as a consequence of the program.

1.9 Appendix

Variable	Valued 1 if ... zero otherwise
Female	female.
Indigenous	consider his/her self as indigenous and speak an indigenous language.
Adults 3	lives in a household with 3 or more persons age 20 or older included himself.
Minors 3	lives in a household with 3 or more persons younger than 20 years old.
Marital status	
Married	married.
Widowed	widowed.
Education	
Some education	has completed one year of formal education but did not finish primary school .
Primary	has completed primary school but no secondary school or further.
Secondary	has completed secondary school or equivalent but not further.
High school & +	has completed high school or equivalent and further.
Income	
Medium	household income is superior to the poorest 1/3 but inferior to the richest 1/3.
High	household income is superior to the poorest 2/3.
House type	house with refrigerator, stove or microwave, and fixed telephone line.
Health	
Good health	declare him/her self as being in good health, five categories.
Good weight	declare him/her self as being in good weight, five categories.
Chronic illness	declare to have a chronic illness.
Disability	declare to have a disability.
Sport	declare to do moderate physical activity for more than 30 min two times per week.
smoked	has ever smoked more than 20 cigarettes in his/her life.
Alcohol drinker	has drunk more than 5dl of wine or equivalent in one occasion at least twice during the last month.
Residence	
Sub urban	locality from 2500 to 99,999 habitants.
Urban	locality 100,000 habitants and more.
North	Chihuahua, Coahuila, Nuevo Leon and Tamaulipas.
North Pacific	Baja California, Baja California Sur, Sonora, Sinaloa, Nayarit, Jalisco and Colima.
Center North	Duarango, Zacatecas, Aguascalientes, San Luis Potosí, Guanajuato and Queretaro.
Center Gulf	Veracruz, Hidalgo, Tlaxaca and Puebla.
Center South	Mexico, Federal District and Morelos.
South East	Yucatan, Quintana Roo, Campeche and Tabasco.

Chapter 2

Optimal subsidy for private health insurance providers

Joint work with Pierre Stadelmann

2.1 Introduction

Most governments allocate a substantial amount of resources to provide private goods or services. In cases where public and private provision are mutually exclusive, individuals have to decide whether to get the freely provided public good or buy it in the private market. Health insurance is a particular industry where we observe this interaction between private and public providers. For instance in Spain, every inhabitant has the right to get health care treatment from public facilities, nevertheless many individuals opt out to by private insurance for private health care. The government saves money as people buy private insurance and are not using the public provision. Tax rebates to buy private insurance have been put in place to encourage individuals to opt out.

In this paper, we discuss the advantages of giving incentives for opting out of the public sector. In our setting, health insurance is publicly and privately available. Public sector provides health care for free to any individual. Poor people have to rely on public provision, due to liquidity constraints. Under those circumstances the public provision of a private good is necessary to secure a minimum level of health care to the whole population.

Richer individuals might be interested in opting out for (costly) private health insurance. Given that there will be a price to pay to access the private market, quality in the private sector needs to be higher to justify this increase in price.

The public budget for health care is fixed. Therefore, the resources available per patient shrink as more people are treated publicly. The government wants to provide the highest possible quality for the poor (universal provision of health care), but it cannot forbid the rich to seek public treatment. However, it can incentivize them to opt out. This increases the resources available for the poor.

How should the government allocate its fixed budget between the two alternatives? It can subsidize the private sector or it can provide health care. We will examine the optimal level of subsidy under perfect and asymmetric information. Under asymmetric information we analyze two possible scenarios. The first one is where private firms cannot distinguish between health risks nor can offer different contracts to induce individuals to self select. Solidarity policy refers to this case, where a normative rule makes everyone pay the same amount of money for a health insurance plan regardless of health status. The second scenario refers to separating contracts, where although firms cannot distinguish between healthy and sick individuals, they can offer different contracts to push individuals to revel their health status.

This paper examines the relationship between public and private providers of health care. This analysis could also be made on education or other publicly provided private goods.

Next section deals with literature review. In section 3, we present the model and its assumptions. We then examine different scenarios, with different information structure. Section 5 presents some examples, before we conclude.

2.2 Literature review

This paper builds on three different strands of literature. The first one is the literature concerning the public provision of private good. Besley and Coate (1991)[8] set up a model where the public sector supplies a discrete private good, such as health or education. Universal provision does not mean that private provision does not exist. Depending on quality, some agents will still benefit from buying the good at a higher quality from the private sector. This permits redistribution from the rich to the poor, but is associated with some dead weight losses. Direct income redistribution via taxes is more efficient, but assumes that income is perfectly observable. Redistribution via universal public provision of a private good is possible even under some form of information asymmetry. Blömquist and Christiansen (1998) [10] examine whether subsidizing the private sector is preferable to public providing. Both instruments lead to some distortion. In their model, the optimal allocation between subsidy and public provision depends on the differences in consumption between the high skill (who over consume) and low skill workers. Blömquist et al. (2010) [9] extend this analysis to cases where the quantity of good publicly provided can be individualized. This can be the case for instance in health care, when it is provided according to needs (the authors provide other examples). They showed that in these cases the taxation can be non-distortive. Hoel and Saether (2003)[22] introduce waiting time in the public provision of health care. Patients with high waiting time costs opt out for private treatment, therefore reducing the costs of the public provision of care. Under some conditions on waiting time and welfare functions, they even recommend subsidizing private provision of care.

Henriet and Rochet (2004)[21] address the question whether public health insurance is an appropriate instrument for redistribution. They argue that under the assumption of negative correlation of income and morbidity, theoretically a public health insurance system financed by taxes can be an efficient mean of redistribution, complementary to income taxation. Nevertheless examining data from the French public insurance system, they find out that poor individuals are using less health services in spite of being in worse health.

We borrow from this kind of models the self-selection mechanisms of the agents into private provision of the good.

The second strand of literature starts with Rotschild and Stiglitz (1976)[32]. In this paper, they show that asymmetry of information in competitive provision of insurance leads to suboptimal results. In particular, agents having an advantage over others cannot get their optimal contract. Using their example of insurance market, agents with comparatively low risk, willing to buy insurance from a competitive provider, incur a loss over their fair contract in order to signal themselves as good risks. This externality, due to the presence of high risk agents in the market, cannot be avoided under imperfect information. This paper has given rise to an important literature in economics.

In our model, we will consider the effects of asymmetry of information in competitive markets, in the presence of public provision.

Glazer and McGuire (2011)[18] model managed competition with demand heterogeneity to create contracts in relation to efficiency and fairness in the context of the recent reform of the American health care system. They consider that heterogeneity in demand for health care is not only due to health status but also other factors which they name taste, represented by income. Efficiency is obtained through standard utility maximization. Fairness is defined as having "the sick and the healthy [paying] the same for plan membership in each plans". They advocate for regulated premiums not only for the basic plans but also on the most generous plans on the stake of efficiency.

From Glazer and McGuire's paper we borrow a part of the structure of the model but we are analyzing different health systems. They describe a health system in which every individual has to buy an insurance having two options: the high (golden) or the low (silver) quality plan. The model is constructed in such a way that the golden plan is optimal for high income individuals whereas the silver plan is the optimal one for the poor independently of their health status. Any rich (high taste for quality) buying a silver plan or a poor (low taste for quality) buying a golden plan is inefficient. The system that we are considering is one where everybody is entitled to use the public services for free. In addition, the rich and only the rich individuals may opt out to the private sector paying the full price offering the optimal quality for them. Comparing our model with Glazer and McGuire's the golden plan would be equivalent to the one proposed to the rich in the private sector. The quality in the public sector (due to a small fixed budget constraint) is lower than in the private sector but it is not necessarily corresponding to the silver plan. First the quality in the public sector may be also suboptimal for the poor. Second, the quality in the public sector depends on how many people are treated in this sector. In our analysis when a rich individual goes to the public sector we identify two types of inefficiencies. The first one as in Glazer and McGuire is coming from a high taste individual contracting a suboptimal quality. The second comes form the fact that it has a negative externality on the rest of the users in the public sector.

The question that we examine, the balance between a subsidy to private provider and the budget available for public provision, has also been treated empirically. Emerson et al. (2001) [17] study a tax reform in UK that caused the private health insurance plans premium for over-60 insurees to raise by a large margin. It impacted negatively the waiting lists (and therefore, the quality) in the public NHS system. Rodriguez and Stoyanova (2008) [31] study a similar tax reform in Spain that eliminated a tax deduction for private health insurance expenditures. This reform induced the Spanish insurees to buy less individual health insurance plans, and turn to group plans. The effect on participation in private insurance plans was not significant. Still the reform alleviated the public expenditures on health care. In contrast, Lopez-Nicolàs and Vera-Hernandez (2008) [27] use micro-simulation on the same tax reform to examine whether tax subsidies in Catalonia are self-financing, reducing the public budget for health care. They find that this tax reform was costly for the public budget.

2.3 The model

We consider three types of players: consumers, public sector and private health insurance providers. The consumers buy health insurance at a given quality. The private providers sell insurance for health care at a given quality for a fair premium.

The public sector (or government) provides care (in an NHS way) at a given quality, lower than the private sector quality, for free. Quality is defined as the health expenditures per illness episode. The government can also offer a subsidy to reduce the price paid in the private sector.

2.3.1 The consumer

Consumers are characterized by their health status and their wealth levels. Consumers can be healthy or sick (denoted by i), and rich or poor (denoted by j). There are then four types of consumers (ij), healthy rich (hr), healthy poor (hp), sick rich (sr) and sick poor (sp). Health status are modeled through the number of illness episodes[1], θ_i. Sick consumers have a number of illness episodes of θ_s, and healthy consumers of θ_h, with $\theta_s > \theta_h > 0$.

For each illness episode, a single unit good of treatment is consumed. The quality of care q is defined as the health expenditures per illness episode θ_i. Therefore, the cost to provide a given level of quality to a given individual for all his illness episodes is

$$c(q) = \theta_i q \tag{2.1}$$

The valuation for quality, influenced linearly by need (i, expected number of illness episodes) and taste (j, wealth), is $v_{ij}(q) = \theta_i \phi_j(q)$. The linearity in terms of need comes from the assumption of homogeneity in illness episodes across individuals. The sick are valuing quality more than the healthy, $v_{sj}(q) > v_{hj}(q)$. The taste for quality $\phi_j(q)$ is increasing and concave in q, and independent of health status. The rich are valuing quality more than the poor, $v_{ir}(q) > v_{ip}(q)$.

If the individual is seeking care from the private sector, he will pay an *ex ante* premium P. Net utility U_{ij} is derived from the valuation for quality, minus the eventual premium.

$$U_{ij} = v_{ij}(q) - P \tag{2.2}$$

The first best level of quality q_j^* maximizes the valuation of quality of a given individual minus the costs of providing this level of quality to this individual.

Lemma 2.3.1 *The first best level of quality is independent of the health status.*

This comes from the assumptions that the valuation functions and the costs are both proportional to the number of illness episodes.

[1] There are no differences in illness episodes between consumers.

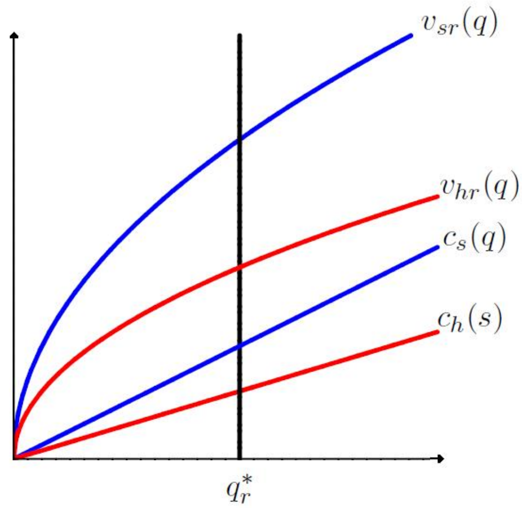


Figure 2.1: Valuation and cost for quality, and its first-best level, for healthy and sick rich

2.3.2 The public sector

The government has a fixed budget B. This budget can be used to produce health care quality and to subsidize the private sector. Public health care is offered as in an NHS insurance system. The subsidy s is a fixed amount of money per illness episode treated in the private sector. It modifies the cost function of the private sector such that it becomes

$$c(q,s) = \theta_i(q - s) \tag{2.3}$$

We name M_{ij} the total number of consumers with health status i and wealth j. We name N the total number of illness episodes in the population. N^G is the total number of illness episodes treated by the public sector (government) and N^P the equivalent in the private sector. We also define N_{ij} as the number of illness episodes of consumers with health status i and wealth j, with then $N_{ij} = \theta_i M_{ij}$. This means that $N = N^G + N^P = \sum_{ij} N_{ij}$.

The quality in the public sector is q^G.

The budget constraint for the government is thus

$$B \geq N^G q^G - N^P s \tag{2.4}$$

For simplification, poor (low taste) individuals have to rely on public services.

Due to a liquidity constraint, or because of a systematic underestimation of the risk by the poor, the state has to provide a minimum level of health care services.

Rich individuals may decide whether they prefer to benefit from the public sector offering a quality q^G, or go to the private sector and pay the market price. Public providers cannot identify who is rich and who is poor[2] but can give incentives (through the subsidy s) to the rich to go to the private sector. Having the public service free of charge ensures that all the individuals are willing to get care.

2.3.3 The private sector

The private provision of insurance is competitive. Firms are proposing (an insurance for) a quality of care q^P for an *ex ante* premium P, in a contract (q^P, P), in order to maximize their profits.

Lemma 2.3.2 *Under perfect competition, and no asymmetric information, private providers offer a fair premium and the first best quality for the rich.*

Lemma 2.3.2 assures that under perfect competition (therefore zero profit) and no distortions, $q^P = q_r^*$ and $P_i = \theta_i q_r^*$. Every rich consumer pays its expected costs in the private market.

2.3.4 Timing of the game

The timing of the game is as follows. The government announces a level of subsidy per illness episode treated in the private sector. Then each firm in the private sector announces the contract it proposes. The quality in the public sector and the number of rich consumers that decide to buy insurance from each sector are simultaneously solved. Rich individuals may switch from one sector to another until there is no marginal individual who would find profitable to switch.

2.3.5 Equilibrium under perfect risk selection and no subsidy

This section will define a simple baseline case. Under perfect risk selection, there is no information asymmetry. The private firm can discriminate contracts (q, P) between sick and healthy rich individuals (the poor have no access to the private

[2]For instance because of an important underground economy, or because the public service is politically defined as universal.

market). Lemmas 2.3.1 and 2.3.2 explain that the quality provided by the private firms to sick and healthy rich will be the same. However, the premiums will be different. For this baseline case, we also consider that the public sector does not offer any subsidy ($s = 0$). In this case, depending on the level of the public budget B, the rich will join or not the private sector. A high public budget, and thus a high quality of public care, induces the rich to enter the public sector.

Poor individuals have to rely on the public providers. Rich individuals maximize their utility, choosing between the public sector quality for free (q^G) and the private sector quality (q_r^*) for a fair premium ($\theta_i q_r^*$). We define $\underline{q}_{ir}^G$ as the minimum quality a rich individual may accept from the public sector providers. Formally, the minimum acceptable quality (MAQ) $\underline{q}_{ir}^G$ is defined as the quality level at which a rich individual is indifferent between the public and the private sector.

$$v_{ir}(\underline{q}_{ir}^G) = v_{ir}(q_r^*) - P_i(q_r^*) \tag{2.5}$$

Below this quality level in the public sector ($q^G < \underline{q}_{ir}^G$), a rich individual will be induced to go to the private sector. Above this quality level ($q^G > \underline{q}_{ir}^G$), the private sector cannot offer a fair contract (q_r^*, P) that attracts him, and he will get care from the public providers, together with the poor.

Lemma 2.3.3 *Under fair prices, without asymmetric information, the minimum quality the rich individuals are accepting from the public sector $\underline{q}_{ir}^G$ is independent from the health status, $\underline{q}_{hr}^G = \underline{q}_{sr}^G$.*

As in lemma 2.3.1, the linearity in the valuation and cost functions leads to the result.

We now consider 3 cases: very low public budget, very high public budget and an intermediary public budget.

If the public budget is very low (lower than B_1)[3] , the quality in the public sector (q^G) will be lower than the MAQ, $q^G < \underline{q}_{ir}^G$, even if the rich buy already insurance from the private sector. The rich individuals have no incentives to switch sectors. In equilibrium, all the poor individuals will get care from the public providers at quality q^G, and all the rich individuals will buy insurance from the private sector at quality q_r^* and premium $\theta_i q_r^*$.

[3] B_1 is the public budget needed to provide $\underline{q}_{ir}^G$ to the poor population in the public sector, $B < B_1 = \underline{q}_{ir}^G(N_{hp} + N_{sp})$.

If the public budget is very high (higher than B_2)[4] , the quality proposed in the public sector (q^G) will higher than the MAQ, $q^G < \underline{q}^G_{ir}$, even if the rich buy already from the public sector. The rich individuals have no incentives to switch sectors. In equilibrium, all the individuals, rich and poor, will get care from the public providers, at quality q^G.

The last case is when the public budget is in a middle range ($B_1 < B < B_2$). If all the individuals are getting care from the public providers, the quality is too low to be accepted by the rich. They will then switch toward the private sector. However, if all the rich individuals are getting insurance from the private sector, the free quality in the public sector is appealing to them. They have then incentives to switch back toward the public sector. In equilibrium, only a fraction of the rich would buy private insurance, and the remainder will get public care, together with the poor. Utilities in both sectors have to be equivalent for the rich $v_{ir}(q^G) = v_{ir}(q^*_r) - \theta_i q^*_r$.

Proposition 2.3.4 *Under perfect risk selection and no subsidy, with public budget in a middle range ($B_1 < B < B_2$), part of the rich individuals are getting insurance in the private sector and the other part are getting care from the public sector. This means that $N^P < N_{hr} + N_{sr}$ and $N^G > N_{hp} + N_{sp}$. The quality in the public sector is equal to $\underline{q}^G_{ir}$.*

If a larger part of rich was getting care from the public sector, the quality in the public sector would deteriorate, and the private sector would become attractive for the rich. If a lower part of the rich was getting care from the public sector, the mirror situation would happen.

Figure 2.2 shows comparative statics, and the equilibrium quality in the public sector q^G, given the public budget B.

When the budget is low, $B < B_1$, an increase in budget is reflected in the quality of the public sector at a rate $\frac{\partial q^G}{\partial B} = \frac{1}{N_{hp}+N_{sp}}$. An increase in the budget is translated into better quality as the number of illness episodes treated remains unchanged (only the poor get treated in the public sector).

Once the public budget is greater than B_2, all individuals (rich and poor) are insured in the public sector so that, as the public budget increases, no new people enter the public sector. Therefore the quality in the public sector increases at a rate $\frac{\partial q^G}{\partial B} = \frac{1}{N}$ (the increase is shared between the total number of illness episodes in the population).

If the public budget is between B_1 and B_2, the rich individuals are attracted by the public sector as the budget increases. The quality in the public sector is

[4] B_2 is the public budget needed to provide $\underline{q}^G_{ir}$ to the whole population in the public sector, $B > B_2 = \underline{q}^G_{ir} N$.

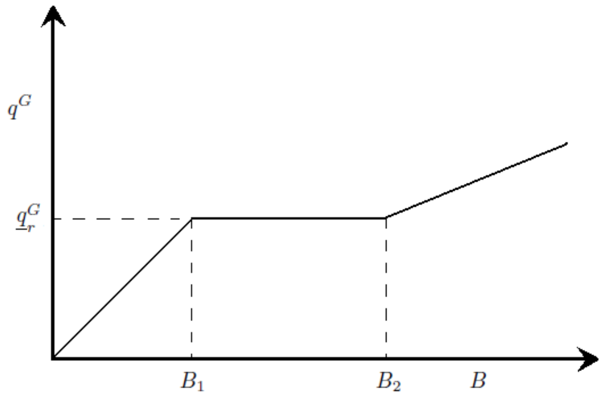


Figure 2.2: Public sector quality and budget

temporarily above $\underline{q}_{ir}^G$, and it attracts more rich individuals. Because the quality decreases when more illness episodes are treated, this brings back the quality to $\underline{q}_{ir}^G$, where no additional rich individual is willing to enter the public sector. In equilibrium, the marginal increase of the public budget on the quality in the public sector is zero, $\frac{\partial q^G}{\partial B} = 0$.

In the remainder of the model, we will restrict the discussion to a public budget such that it cannot provide a quality beyond the first best quality for the poor, $B \leq N_p q_p^*$. We ensure that the marginal value of a quality increase in the public sector is greater for the poor than its costs.

2.4 Implementing a subsidy

2.4.1 Perfect risk selection

With a limited budget, it is still perfectly possible that the rich have incentives to get care from the public sector, because it is free of charge. But because the budget is fixed, treating more people (or a greater number of illness episodes) results in a lower quality in the public sector. This is not the case in the private sector, where every individual has to pay the amount needed to treat his own illness episodes.

The most efficient outcome[5], is for the rich to get insurance in the private

[5]Maximizing a utilitarian social welfare function of the total surplus from health care over costs, whether it is publicly or privately financed

$$max \sum_{ij} (v(q_{ij}) - c(q_{ij}))$$

sector, while the poor are treated in the public sector. The rich would get their first best level of quality, while the poor would get the highest possible quality given the public budget B and their liquidity constraint.

The government, willing to maximize the level of quality offered to the poor, will offer a subsidy just sufficient for all the rich to be willing to buy the private insurance quality. This will reduce the number of people seeking care in the public sector, therefore improving its quality. It will also reduce the price paid in the private sector by the rich. This is Pareto improving, as long as the subsidy is less costly to the government than treating those not willing to switch in the absence of a subsidy.

Lemma 2.4.1 *Under perfect risk selection and no asymmetry of information, it is always cheaper for the public sector to subsidize the rich so that they opt out for the private sector rather than treating them directly.*

The budget constraint of the government leads the public quality to be lower than the first best quality. The definition of the first best level of quality ensures that the utility (net of costs) of q_r^* is bigger than the utility (net of costs) of the public sector quality q^G. The rich have a positive willingness to pay over the costs of public quality to get this increased utility.

With such a subsidy, each unit of treatment is reimbursed by the government an amount s. The cost function, defined by equation 2.1, is modified such that, for the private sector, the cost function is defined by equation 2.3.

The subsidy does not affect the first best level of quality of the consumers (particularly the rich). It corresponds to a lump-sum transfer per illness episode. It therefore has no distortive effects[6]. However, because of perfect competition, it will reduce the premium P_i paid to buy the first best level of quality q_r^* in the private sector. With a subsidy s, this premium becomes

$$P_i = \theta_i(q_r^* - s) \tag{2.6}$$

Note that, as we consider perfect risk selection, the premium paid by healthy and sick rich are different, even though the quality level is the same.

As previously, the equilibrium is attained when the rich individuals are indifferent between getting care in the public and insurance from the private sector,

[6] The first best level of quality without a subsidy is defined as $q_j^* = argmax_q(v_{ij}(q) - \theta_i q)$. With a subsidy, it becomes $q_j^* = argmax_q(v_{ij}(q) - \theta_i(q - s))$. The derivatives of these functions with respect to q are equal.

taking now into account the subsidy s. Substituting the fair price with a subsidy, defined in equation 2.6, into the indifference condition 2.5, we get

$$v_{ir}(\underline{q}_{ir}^G) = v_{ir}(q_r^*) - \theta_i(q_r^* - s) \tag{2.7}$$

Equation 2.7 implicitly defines the function $\underline{q}_{ir}^G(s)$, which relates the MAQ with the subsidy level. Note that lemma 2.3.3 still applies, the MAQ are independent from the health status.

Lemma 2.4.2 *The minimum acceptable quality in the public sector $\underline{q}_{ir}^G(s)$ increases with s at an increasing rate, $\frac{\partial \underline{q}_{ir}^G(s)}{\partial s} > 0$, and $\frac{\partial \underline{q}_{ir}^G(s)^2}{\partial^2 s} > 0$.*

The bigger the subsidy, the less costly it is for the rich to get insurance in the private sector, so the quality they are ready to accept from the public sector needs to be higher.

With a subsidy respecting the indifference condition 2.7, the rich individuals are buying insurance from the private sector and the poor are receiving it from the public sector. This means that $N^G = N_{hp} + N_{sp}$ and $N^P = N_{hr} + N_{sr}$. The budget constraint of the government, equation 2.4, can be rewritten

$$q_p^G = \frac{B - s(N_{hr} + N_{sr})}{N_{hp} + N_{sp}} \tag{2.8}$$

This defines $q_p^G(s)$, a budget constraint that would represent the quality in the public sector, available to the poor, as a function of the subsidy s, when all rich individuals are in the private sector. The quality affordable in the public sector $q_p^G(s)$ decreases linearly with the subsidy s.

In figure 2.3, we plot the two functions relating the subsidy level s to the quality in the public sector q^G. The first one is the minimum acceptable quality (MAQ) for the rich, as a function of the subsidy $\underline{q}_{ir}^G(s)$. Quality needs to be below this level for the rich to be willing to buy private insurance. The second one is the budget constraint of the government, given the subsidy, $q_p^G(s)$. Quality also needs to be below this line to respect it. Let us recall that the government objective function is to maximize the quality available to the poor in the public sector, q^G.

The optimal level of subsidy, s^*, is such that functions $\underline{q}_{ir}^G(s)$ and $q_p^G(s)$ cross. At this subsidy level, the quality is maximized for the poor in the public sector, and the rich are indifferent between the quality in the public sector and the private market quality.

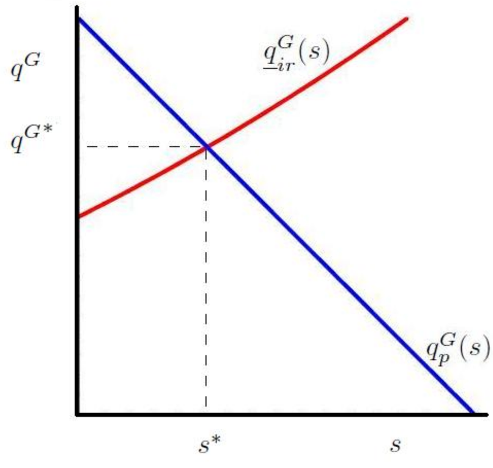


Figure 2.3: Public sector quality and subsidy

Proposition 2.4.3 *Under perfect risk selection, a subsidy s^*, defined as $\underline{q}_{ir}^G(s^*) = q_p^G(s^*)$, maximizes the objective function of the government. For $s^* > 0$, it is also an improvement in a Pareto sense over the no subsidy case.*

At $\underline{q}_{ir}^G(s^*) = q_p^G(s^*)$, the quality in the public sector is maximized, as the rich are opting out, and they are cheaper to subsidize than to treat. The poor are therefore better off. A positive subsidy can only increase the welfare of the rich.

The poor are getting a higher quality, because the rich are out of the public sector. The rich are not willing to participate in the public sector, even though the quality increases as a result of the subsidy policy. By construction, they are indifferent between the public and the private sector provision.

Note that it would be perfectly possible to observe a case where $s^* < 0$, the subsidy being in effect a tax. This would mean that the public budget is low enough, such that the budget constraint $q_p^G(s)$ defined in equation 2.3 crosses the minimum acceptable quality for the rich $\underline{q}_r^G(s)$ defined in equation 2.7 at a point where $s < 0$.

2.4.2 Solidarity between sick and healthy individuals in the private sector

In the previous section, the healthy and sick rich were paying different premium for the same quality level. Regarding health care, a normative rule that is widely accepted is solidarity among sick and healthy patients. The government might be willing to impose solidarity in the private sector, between healthy and sick rich.

Discrimination based on health status is not possible, either because of asymmetry of information or because regulation prevents it. Additionally, the government will forbid competition in contracts (q, P), allowing only competition in prices. In such cases, the risks are pooled in the private sector. The premium is the same for every consumer seeking private insurance. Because of perfect competition, the firms will then rely on average cost pricing. Another explanation would be the existence of a (perfect) risk adjustment mechanism. Such a mechanism will smooth the costs among the risk types in the private sector, and also lead to average cost pricing.

We impose in this section that the private firms cannot offer different contracts to the healthy and sick individuals[7]. The quality level is q_r^*. The fair premium for any level of quality is therefore the average cost for all the individuals buying the private product. The subsidy provided by the government can induce the rich and healthy individuals (the pivotal consumers) to join the private sector (effectively subsidizing the sick), increasing the utility in both the public sector and private sector.

Average cost pricing implies that the premium paid by healthy and sick rich opting out is the same. But its level depends on the participation of the healthy rich in the private market. If all rich (healthy and sick) individuals are participating in the private sector, the price would be equal to the average cost, $P_h(q_r^*) = P_s(q_r^*) = \frac{N_{rs}+N_{rh}}{M_{rs}+M_{rh}}(q_r^* - s)$. If only the sick rich buy private insurance, the equilibrium price becomes $P_{s,q_r^*} = \theta_s(q_r^* - s)$. Because the sick rich have a higher valuation for quality than the healthy rich , they are the first ones to join the private sector. Their willingness to pay for quality is higher. At some levels of prices, the rich and healthy are still better off in the public sector.

We will now have two indifference conditions for the healthy and rich out of equation 2.5, one where all the rich (healthy and sick) are treated in the private sector, and one where only the sick rich buy the private insurance. The MAQ for the sick rich, when the healthy rich are not participating in the private sector, is $\underline{q}_{sr}^G(s)$, defined through equation 2.7. When the healthy rich are participating in the private sector, the sick rick are subsidized, and therefore anyway willing to participate in the private sector. The healthy rich face different prices in the private sector, depending on whether they are already opting out, or whether they are publicly treated. Their MAQ are different.

$$v_{hr}(\underline{q}_{hr}^G) = v_{hr}(q_r^*) - \frac{N_{sr} + N_{hr}}{M_{sr} + M_{hr}}(q_r^* - s) \tag{2.9}$$

$$v_{hr}(\underline{q}_{hr}^G) = v_{hr}(q_r^*) - \theta_s(q_r^* - s) \tag{2.10}$$

[7]Note that we also assume that private providers cannot specialize into treating only the sick or only the healthy.

We name $\underline{q}_{hr}^{G[1]}(s)$ and $\underline{q}_{hr}^{G[2]}(s)$ the implicit functions defined by equations 2.9 and 2.10 respectively. Those equations relate the MAQ for healthy rich individuals to be indifferent with the private sector at a fair market price, with them being in the private sector ($\underline{q}_{hr}^{G[1]}(s)$, equation 2.9) or not ($\underline{q}_{hr}^{G[2]}(s)$, equation 2.10). The solidarity policy represents an increase in the premium for healthy rich individuals with respect to the perfect risk selection case. It induces the functions $\underline{q}_{hr}^{G[1]}(s)$ and $\underline{q}_{hr}^{G[2]}(s)$ to be shifted to the right of the $\underline{q}_{sr}^{G}(s)$ function[8].

Lemma 2.4.4 *Under a solidarity policy, the minimum acceptable qualities* $\underline{q}_{hr}^{G[1]}(s)$ *and* $\underline{q}_{hr}^{G[2]}(s)$ *in the public sector for the healthy rich are increasing and convex in s. At any subsidy level s, we have that* $\underline{q}_{sr}^{G}(s) > \underline{q}_{hr}^{G[1]}(s) > \underline{q}_{hr}^{G[2]}(s)$.

The bigger the subsidy, the less costly it is for the rich to get insurance in the private sector, so the quality they are ready to accept from the public sector needs to be higher, irrespective of their health status. Because of the health risks ordering, it is easier to convince the sick to opt out than the rich. At the same time, it is easier to convince a healthy to opt out when other healthy already opted out, improving the risk pool in the private sector. The healthy rich have to decide between subsidizing the sick rich and giving up on the additional quality available in the private sector.

We also define the government budget constraint when healthy rich are not participating in the private market, $q_{hr}^{G}(s)$.

$$q_{hr}^{G}(s) = \frac{B - sN_{sr}}{N_{hp} + N_{sp} + N_{hr}} \tag{2.11}$$

The quality affordable in the public sector when the healthy rich are also treated by public providers, $q_{hr}^{G}(s)$, decreases with the subsidy s. If all the rich (healthy and sick) are opting out, the budget constraint of the government is q_p^G, defined by equation 2.8.

In figure 2.4, we plot the MAQ for the sick rich $\underline{q}_{sr}^{G}$, for the healthy rich when only sick rich are in the private sector $\underline{q}_{hr}^{G[1]}(s)$ and for the healthy rich when all the rich opt out $\underline{q}_{hr}^{G[2]}(s)$. We also plot the government budget constraint when the rich are all participating in the private sector $q_p^G(s)$ and when only the sick rich are buying private insurance $q_{hr}^{G}(s)$.

At a subsidy level s_1^*, the sick rich individuals are willing to leave the public sector. Because only the sick individuals are in the private sector, the price is high

[8]Note that, because of Lemma 2.3.3, $\underline{q}_{sr}^{G}(s) = \underline{q}_{ir}^{G}(s)$, as seen in the discrimination case.

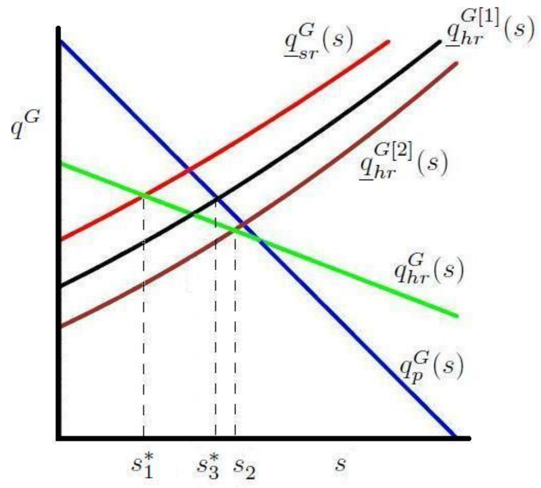


Figure 2.4: Public sector quality and subsidy under health solidarity policy

and the healthy rich do not want to join the private sector. In order to induce the healthy rich to join the private sector, the level of the subsidy has to reach s_2. At this subsidy level, all the rich (healthy and sick) are willing to join the private sector. Once the healthy rich switch from the public to the private sector the average risk in the private sector improves, which leads to a decrease in the average cost and therefore a decrease in the premium. Thus there is even more incentives to participate in the private sector. As the risk in the private sector lowers, the minimum acceptable quality in the public sector for the healthy rich individuals changes from function $\underline{q}^{[2]}_{hr}(s_2)$ (high average cost) to $\underline{q}^{[1]}_{hr}(s_2)$ (low average cost). Consequently, quality in the public sector jumps from $q^{G[2]}_{hr}(s_2)$ to $q^{G[1]}_{hr}(s_2)$. In order to sustain this equilibrium, the necessary level of subsidy is reduced to s_3^*. A subsidy level s_3^* is not sufficient to induce the healthy rich to move to the private sector when the average cost is high (only the sick rich are in the private sector). However, it is sufficient to induce them to stay in the private sector when the average cost is low (all the rich are in the private sector).

There are two equilibriums, s_1^* where the sick rich are in the private sector, all the other consumers are in the public sector, and s_3^* where the (healthy and sick) rich are in the private sectors and the poor in the public sector. It is not clear which of the two equilibriums would lead to a higher quality in the public sector (and therefore for the poor). The advantage of the equilibrium s_3^* is that it reaches the first best quality level q_r^* for all rich individuals, and at the same time the solidarity policy is effective (the healthy subsidize the sick in the private sector). If $\underline{q}^{G[1]}_{hr}(s_3^*) > \underline{q}^{G}_{hr}(s_1^*)$, then s_3^* clearly would be Pareto superior to s_1^*. In this case, the quality the public sector can offer is higher when all the rich are in the private sector. On the contrary, if $\underline{q}_{hr}^{G}(s_1^*) > \underline{q}_{hr}^{G[1]}(s_3^*)$, neither of the two equilibrium would Pareto dominate the other, and there would be a trade off between effectively implementing solidarity in the private sector (decreasing the premium for the sick rich) and the welfare of the poor (offering a higher quality in the public sector under s_1^* than under s_3^*).

Proposition 2.4.5 *There are two potential equilibrium, at s_1^*, where the healthy rich are in the public sector, and s_3^*, where all the rich are opting out. If and only if $\underline{q}_{r}^{G[1]}(s_3^*) \geq \underline{q}_{sr}^{G}(s_1^*)$, then s_3^* is Pareto dominating s_1^*.*

Because of risk pooling in the private sector, the healthy rich are facing a tradeoff. Either they accept to subsidize the sick rich, or they give up on the additional quality that the private sector can offer. Therefore, it is more costly to subsidize the healthy than the sick. It might be more costly to subsidize them than to treat them. If it is cheap enough to subsidize them, the poor are better off, and the sick rich are benefiting from an improved risk pool.

2.4.3 Risk selection with asymmetry of information

In a system where 2 risks types coexist, but the risk type is a private information, a separating contract is 2nd best efficient and achievable.

In this type of setting, the low-risk type do not get their first best contract. They however incur a loss to signal their type in an incentive-compatible way. As under the previous solidarity policy, the healthy rich face the tradeoff of not getting the higher private quality, or giving up part of this quality to signal themselves as good risks. We turn to such a framework.

In the public sector, again only one contract is offered. In the private sector, however, two different contracts are proposed to the rich. They are incentive-compatible in the sense that sick rich are not willing to buy the contract proposed to the healthy rich . The sick rich get their first best contract q_r^* at a price $P_{sr} = \theta_s(q_r^* - s)$. The healthy rich[9] are getting a rebate to buy a lower quality q_{hr} at a price $P_{hr} = \theta_h(q_{hr} - s)$. The incentive compatibility constraint (ICC) is as follows:

$$v_{sr}(q_{hr}) - P(q_h r) \leq v_{sr}(q_r^*) - P(q_r^*) \tag{2.12}$$

[9]The healthy rich could not get their first best contract. If it was the case, it would be cheaper for the sick rich to buy this contract than the one designed for them.

ICC 2.12 postulates that sick rich people would not benefit if they mimic the behavior of the healthy. No other ICC is needed, as healthy individuals would have no interest in reporting that they are sick and paying the premium designed for the sick. However, equation 2.12 will be binding, and can be rewritten in the form of an equality, imposing fair premiums.

$$v_{sr}(q_{hr}) - \theta_h(q_{hr} - s) - v_{sr}(q^*) + \theta_s(q_r^* - s) = 0 \tag{2.13}$$

Equation 2.13 implicitly defines a maximum quality $\overline{q}_{hr}(s)$ that can be offered to the healthy rich, as a function of the subsidy s. Any fair contract where $q_{hr} > \overline{q}_{hr}(s)$ would also attract the sick rich. Quality level $\overline{q}_{hr}(s)$ is as close as possible to the first best, while remaining incentive compatible.

Lemma 2.4.6 *Under risk selection with asymmetric information, the sick rich are getting their first-best level of quality, q_r^* at a fair premium $P(q_{sr}) = \theta_s(q_r^* - s)$. The healthy rich are getting quality $\overline{q}_{hr}(s)$ at a fair premium $P(q_{hr}) = \theta_h(\overline{q}_{hr}(s) - s)$. The decrease in quality incurred by the healthy rich to signal themselves as good risks is reduced by the subsidy.*

Because of incentive compatibility constraints, the healthy rich have to pay a price to signal themselves as good risks. They are therefore not getting the first best quality, while the sick rich don't have this problem. Because of the subsidy, the premium is reduced for the sick. They are therefore less tempted by a lower quality at a lower price. This lower quality that the healthy are getting can be higher.

For the rich to be willing to enter the private market, the contract for the healthy rich has also to satisfy their MAQ.

$$v_{hr}(q^G) = v_{hr}(\overline{q}_{hr}) - P_{hr} \tag{2.14}$$

Equation 2.14 implicitly defines the function $\underline{q}_{hr}^G(s)$, which relates the minimum acceptable quality level in the public sector for the healthy rich with the subsidy level s. The minimum acceptable quality for the sick rich, $\underline{q}_{sr}^G(s)$, is again defined through equation 2.7. Note that, if the quality in the public sector is such that the healthy rich are willing to enter the private market, the sick rich, that get their first best contract, are anyway willing to enter the private market, $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^G(s)$.

Lemma 2.4.7 *Under risk selection with asymmetric information, the minimum acceptable quality in the public sector for the healthy rich is increasing with s at an increasing rate, $\frac{\partial \underline{q}_{hr}^G(s)}{\partial s} > 0$. Healthy rich are pivotal, $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^G(s)$.*

The bigger the subsidy, the less costly it is for the rich to get insurance in the private sector, so the quality they are ready to accept from the public sector needs to be higher. Healthy rich are not getting their first best quality, but still paying fair premiums. Their utility in the private sector is lower than the utility of the sick, and they are therefore more easily interested by the public sector quality.

As in the solidarity setting presented earlier, the budget constraint when only the sick rich are treated in the private sector $q_{hr}^G(s)$ is defined in equation 2.11. The budget constraint where all the rich are treated in the private sector $q_p^G(s)$ is defined in equation 2.8.

In figure 2.5, we plot the MAQ for the sick rich participating alone in the private sector $\underline{q}_{sr}^G$ and the MAQ for the healthy rich also participating $\underline{q}_{hr}^G(s)$.

The government budget constraints when the rich are all participating in the private sector $q_p^G(s)$ and when the healthy rich are instead participating in the public sector, but the sick rich are still participating in the private sector, $q_{hr}^G(s)$ are also represented.

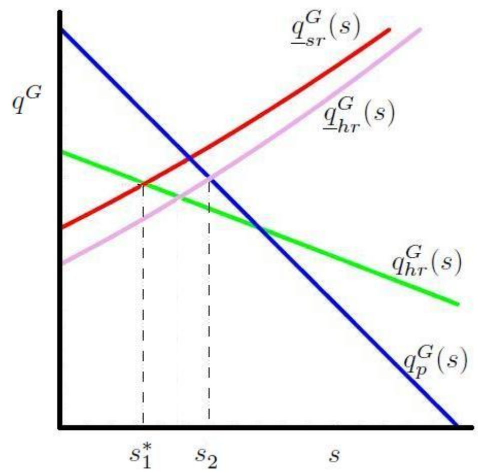


Figure 2.5: Public sector quality and subsidy under separating contracts

Again two equilibriums are possible. The first equilibrium is when only the sick rich are buying private quality care through insurance, at a subsidy level s_1^*. At this subsidy level, the healthy rich are not willing to enter the private sector, because the quality in the public sector is above their minimum acceptable quality $\underline{q}_{hr}(s)$. The equilibrium is sustainable, as the budget constraint $q_{hr}^G(s)$ assumes a subsidy only for the sick rich, and treatment for the healthy rich. The second equilibrium, at subsidy level s_2^*, takes place when all the rich are participating in the private sector. The MAQ that matters is the one of the healthy rich $\underline{q}_{hr}^G(s)$. Subsidy level s_2^* is also feasible, lying on the budget constraint $q_p^G(s)$. It is not clear which of the two equilibriums would lead to a higher quality in the public sector (and therefore for the poor).

Proposition 2.4.8 *There are two potential equilibrium, at s_1^*, where the healthy rich are in the public sector, and s_2^*, where all the rich are opting out. If and only if $\underline{q}_{hr}^G(s_2^*) \geq \underline{q}_{sr}^G(s_1^*)$, then s_2^*, where the healthy rich are participating in the private market, is Pareto dominating s_1^*, where the healthy rich are receiving public care.*

Again, the healthy rich face a tradeoff between signalling themselves as good risks or giving up on the additional private sector quality. Because of it, it is more costly to subsidize the healthy than the sick. It might be more costly to subsidize them than to treat them. If it is cheap enough to subsidize them, the poor are better off.

2.5 Model example

To illustrate our insights we introduce the following example where the value function for quality takes the form $v_{ir}(q) = \theta_i k q^{\frac{1}{a}}$. The parameter $a > 1$ is an indicator of the concavity (inverse elasticity) of the utility function with respect to the quality of health care[10]. $k > 0$, is a scaling factor for the utility function with respect to the marginal utility of quality. Based on this example, we want to illustrate some predictions for different budget sizes, proportions of the population of sick and healthy, rich and poor and difference in the number of illness episodes between the healthy and sick individuals.

We set specific values for the parameters in the reference case of our example, $a = 2$, $k = 8$, $\theta_h = 4$, $\theta_s = 5$, $M_{sp} = M_{sr} = M_{hp} = M_{hr} = 25$. Finally, the budget is such that the quality in the public sector, if all individuals are receiving public care, is 1/4 of the optimal quality q_r^*, $B = \frac{0.25 q_r^*}{\theta_s M_{sp} + \theta_s M_{sr} + \theta_h M_{hp} + \theta_h M_{hr}}$. This imposes that the quality of the public sector, when treating all the agents in the population, is standardized for all variations of the model that we will introduce. This set of parameters leads to $q_r^* = 16$, $q^G = 4$ if everybody (rich and poor) is in the public sector. All the potential equilibrium, and the values of q^G and s associated with them, are listed in the appendix. For example, under perfect information, with the set of parameters listed above, $q^G(s^*) = 5.40$ and $s^* = 2.60$.

With those values, we do not pretend to calibrate the model in comparison to the reality; we rather sketch what may be the possible scenarios with different relative size of the parameters.

[10]We need that $a > \frac{\theta_s}{\theta_h}$, while not being "'too big"'. If this is not the case, we end up with weird solutions, implying negative utilities, or negative private sector quality.

In the subsequent sections, we are going to analyze the effect of changing one of the parameters (B, M_{ij}, θ_i) on the potential equilibrium under perfect information, solidarity policy and separating contracts.

2.5.1 Budget change

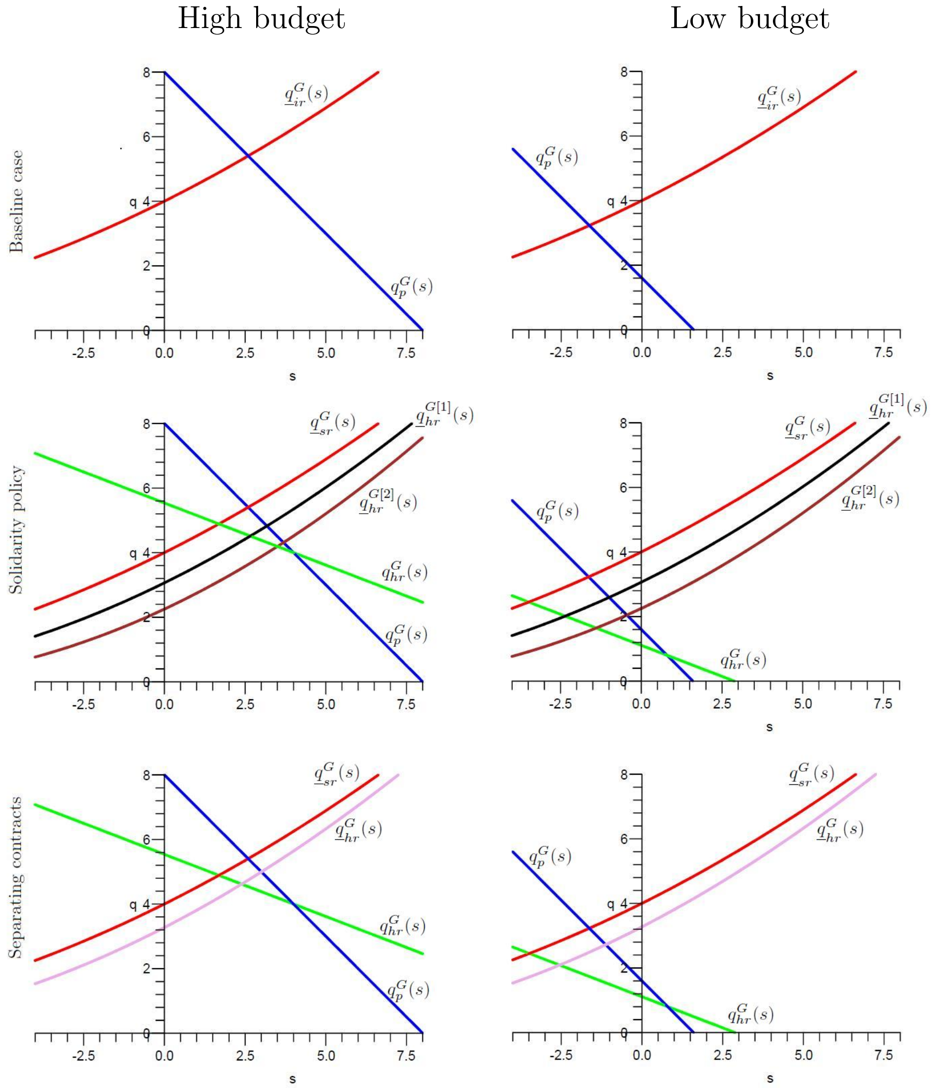
In figure 2.6, we compare the reference case with a budget that is reduced to 20% of the baseline budget. The result is that no positive subsidy s could improve the quality in the public sector, for none of the three cases analyzed: perfect information, solidarity policy and separating contracts. In fact, if a tax on the private providers is possible ($s < 0$), it would increase the quality in the public sector.

In the perfect information scenario, reducing the public budget to 20% of its original value leads to a quality reduction in the public sector of less than a half, from 5.40 to 3.22. The slower decline in the public sector quality is explained by a change in the optimal subsidy from 2.60 to - 1.63 monetary units.

With a higher budget, the subsidy is less costly than treating people in the public sector. With a high budget the quality in the public sector is 4 if rich and poor are treated in the public sector. Having a subsidy of 2.60 monetary units induces the rich to opt out to the private sector. The quality in the public sector becomes 5.40. The subsidy is less than half of what rich would cost if they were treated in the public sector.

In the solidarity policy and separating contracts scenarios, we also observe that the quality reduction in the public sector is lower than the reduction in the budget. The budget constraints $q_p^G(s)$ and $q_{hr}^G(s)$ keep the same slopes but they are shifted to the left. The MAQ functions are independent of the budget size.

Figure 2.6: Example different size in budget



2.5.2 Different proportions of rich and poor

We revert to the original set of parameters. Changing the proportion in the number of rich and poor is reflected in a change of the slopes of the budget constraints $q_p^G(s)$ and $q_{hr}^G(s)$. The bigger the share of rich people, the steeper the slopes of the budget constraints, therefore the potential benefit of increasing quality in the public sector through a subsidy policy is higher when the proportion of poor is low.

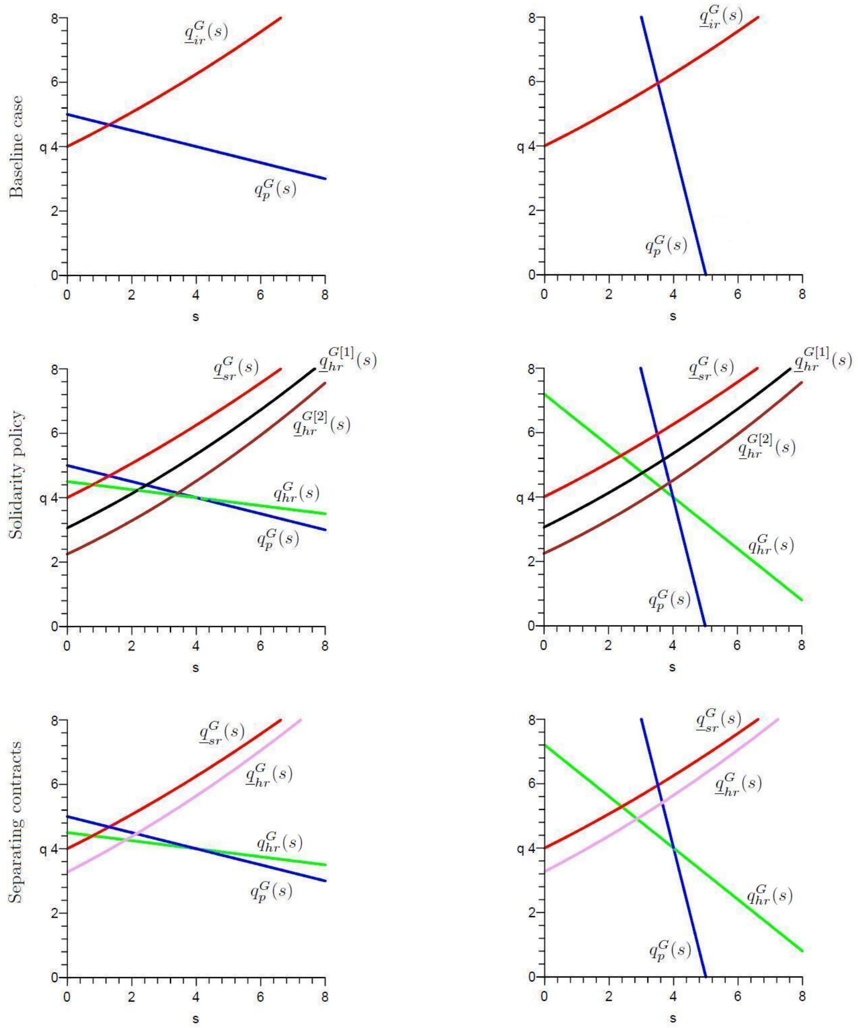
In figure 2.7, we change the share of poor and rich. On the left hand side, the poor represent 80% of the population. On the right hand side, they represent only 20 percent. The budget remains unchanged in either case, such that if everyone is treated in the public sector, the quality q^G would be equal to 4.

Under perfect information, the optimal subsidy and the quality in the public sector is higher when the share of poor is lower. In our example, $q^G(s^*) = 5.75$, and it drops to 4.43 when poor represent 80% of the population. The optimal subsidy changes from 2.29 to 0.83 as the share of poor increases. This result again illustrates the fact that it is cheaper to subsidize the private sector than to treat people in the public facilities. Having less poor individuals reduces the number of people that would get treated in the public sector if the subsidy policy takes place.

We show these results for the solidarity policy and separating contracts scenarios, but the analysis does not change, except for the scale of the potential benefits of applying the optimal subsidy.

Figure 2.7: Example different proportion rich poor

High proportion of poor High proportion of rich



2.5.3 Different proportions of healthy and sick

In figure 2.8, we change the proportion of sick and healthy people. On the left hand side, sick individuals only represent 20% of the population. On the right hand side, sick individuals represent 80 percent of the population. Changing the proportion of sick does not have any impact under perfect information (because B is standardized with respect to the number of illness episodes). The optimal subsidy is 2.60 and the quality in the public sector is 5.40, regardless of the proportion of healthy and sick.

Under the solidarity policy, we observe that with a low proportion of sick individuals, the equilibrium where healthy and sick rich are opting out for the private sector reports higher quality in the public sector, 5.16. When the sick rich are alone in the private sector, the quality in the public sector is only 4.43 units. The participation of both groups in the private sector makes the solidarity policy effective. In contrast, when the proportion of sick people is 80 percent, the quality in the public sector is going to be higher if only the sick rich are in the private sector, 5.22 compared to 4.41 when all the rich are seeking care through the private insurance.

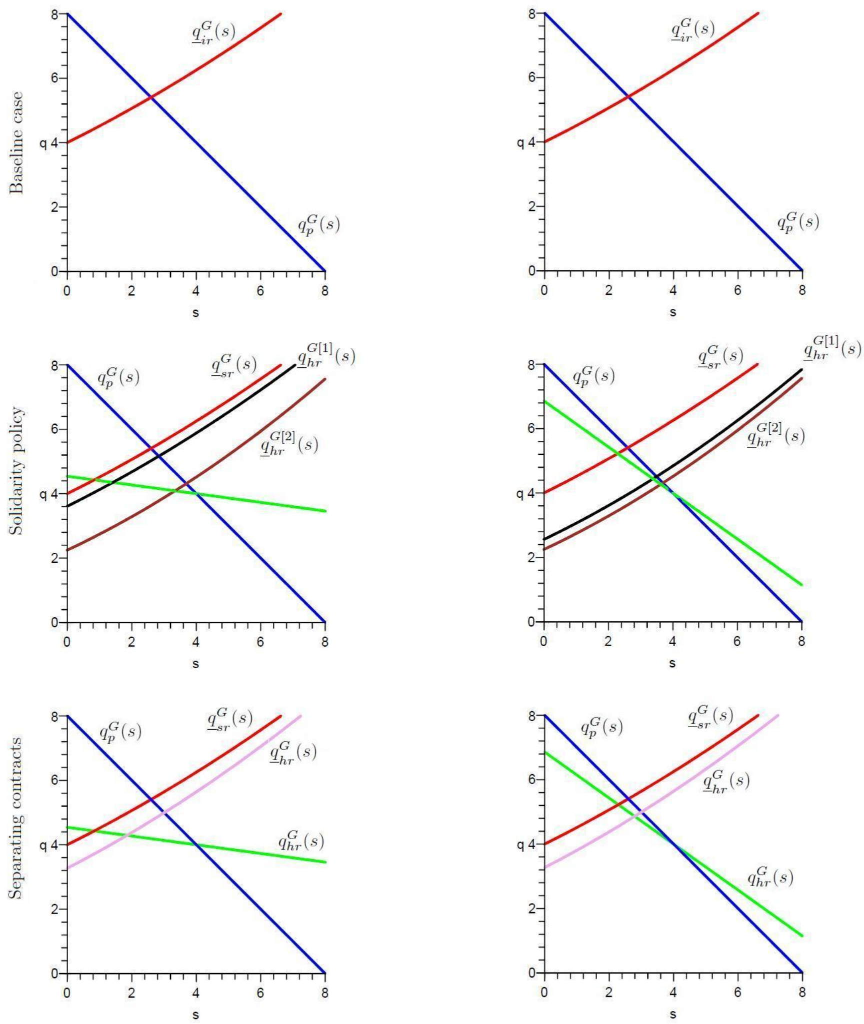
The separating contracts scenario shows a similar pattern. If the share of sick is high, the equilibrium with only sick people in the private sector reports higher quality in the public sector than having all rich in the private sector. And if the share of sick is low, the equilibrium with all the rich in the private sector is preferable.

Comparing the solidarity and the separating contracts scenarios, with a low share of sick people, the solidarity policy reports higher quality in the public sector and is Pareto superior. In contrast, if all rich people are in the private sector, a high share of sick people leads, in the separating contract scenario, to report higher quality in the public sector, which is better for the poor. This comes from the fact the MAQ for the healthy rich, when all rich individuals are in the private sector, is shifted toward the right in the solidarity policy scenario. In the separating contracts scenario, the same MAQ is independent of the share of healthy and sick people.

When there are few sick, it is interesting to note that the solidarity policy, putting barriers to efficiency in the private sector, leads to a higher public quality ($q^G(s^*) = 5.16$) than the separating contracts ($q^G(s^*) = 5.00$). It is therefore Pareto superior.

Figure 2.8: Example different proportion healthy sick

High proportion of healthy — High proportion of sick



2.5.4 Different gap on the number of illness episodes between the healthy and sick individuals

We illustrate the implications of having a greater gap between the healthy and the sick in terms of illness episodes in figure 2.9. On the left hand side, the sick have 66% more illness episodes than the healthy, $\theta_s = 5$ and $\theta_h = 3$. On the right hand side, they only 11% more, $\theta_s = 5$ and $\theta_h = 4.5$.

Under perfect information, there is no change, as the gap between the healthy and sick increases. On the other hand in the solidarity policy and separating contracts scenarios, we observe drastic implications.

In the solidarity policy scenario, the distance between the MAQ for healthy and sick rich expands very fast, as the gap in the number of illness episodes increases. This makes it hard to convince the healthy rich individuals to opt out for the private sector. The subsidy is 4, the same as the cost of treating everybody in the public sector. If only sick rich are in the public sector, public quality becomes 4.98. This is better than giving incentives for the healthy rich to opt out for the private sector. The solidarity policy is not effective and everybody is worse off than in the perfect information scenario.

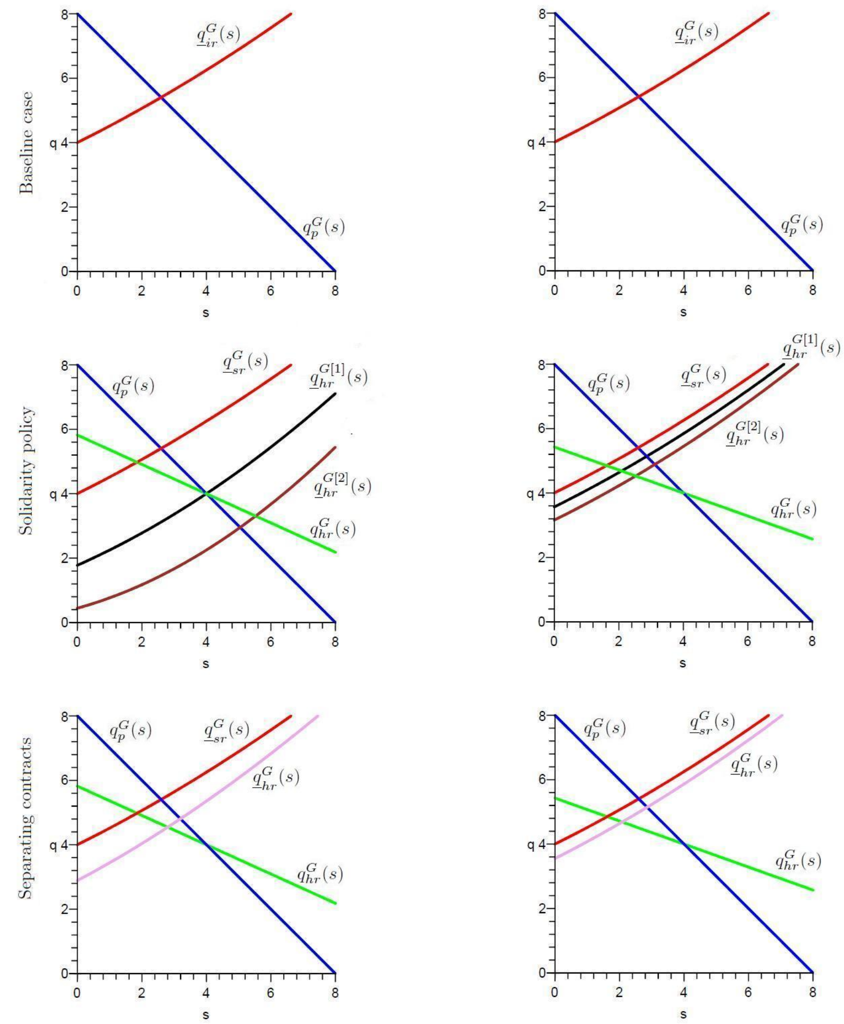
When the gap in the number of illness episodes is small, on the contrary, it is preferable, in terms of public quality, to induce the healthy rich to opt out as well. Quality becomes $q^G(s^*) = 5.14$ when the healthy rich are opting out, rather than 4.85 when they are getting treated in the public sector.

In the separating contracts scenario, the distance between the MAQ for the sick and healthy rich expands as the difference in the number of illness episodes increases. But this increase is slower than in the solidarity policy. The analysis remains comparable to the solidarity scenario.

If the gap in illness episodes is big, an effective solidarity policy is very costly in terms of public quality compared with a situation where only the sick rich are opting out. In this case, letting the market set up separating contracts is beneficial for the public quality. If the gap in illness episodes is small, the solidarity policy can be effectively implemented, leading to a higher public quality when all the rich opt out. However, the separating contracts scenario is still better.

Figure 2.9: Example different gap on the illness episodes

High difference in illness episodes | Low difference in illness episodes



2.6 Conclusion

In this paper we analyzed the public provision of health insurance with heterogeneous agents (in wealth and health status) in a context where private and public providers coexist. Public provision is universal and free. Poor individuals have to rely on public services. Rich individuals may opt out to private providers by paying a premium. Quality is defined as health expenditures per illness episode.

We showed that under perfect information giving a subsidy to the private sector, such that no rich individual would demand public treatment, is Pareto improving, increasing the quality in the public sector which is better for the poor. If health status is not verifiable (asymmetric information), the maximum quality in the public sector is lower than in the perfect information case. It is not longer true that a subsidy that induces all the rich to opt out maximizes the quality in the public sector. It may be that the quality in the public sector is maximized with a subsidy where only the sick rich individuals get private insurance.

Under asymmetry of information, we studied scenarios where competition in contracts is prevented (solidarity policy) and permitted (separating contracts). Under the solidarity policy, the optimal level of subsidy is more sensitive to the proportion of sick and healthy people and to the difference in the number of illness episodes than under separating contract. Under separating contracts, a positive subsidy will reduce the costs of the healthy rich to signal themselves as good risks. If the level of subsidy is such that all rich are insured in the private sector, with a low proportion of sick people and low difference in illness episodes between sick and healthy, preventing competition in contracts is Pareto improving.

This result implies that the quality in the public sector, available to the poor, can be higher in a third best world than in a second best situation. A first-best situation is not achievable in this model due to fixed public budget and congestion in the public sector. In a second-best world, perfect information leads to all the rich opting out. With asymmetric information, it is possible to introduce redistribution from the healthy rich toward the poor and the sick rich. This depends on the proportion of healthy and sick individuals as well as on the difference in the number of illness episodes between the healthy and the sick.

We made some simplifying assumptions. First, our model relies on constant returns to scale technology for the production of quality. There are also only two wealth levels and two health statuses, rather than a continuum. There is perfect identification of an illness episode, for instance in terms of severity, or discretionary power of the physician. Changing some of those assumptions may have implications on our conclusions.

We discuss the implications of a public subsidy to private providers in terms of health insurance. This analysis could also apply to other domains, such as education, child care or elderly care.

This model permits to illustrate in a simple framework that public support to private providers can be justified. If a private good is an alternative to the public provision, a subsidy that reduces the price of the private alternative might free valuable resources. These resources can then be reinvested in the public provision, hopefully improving its quality.

2.7 Appendix

Table 2.1: Example values

	Buget change		Proportion rich/poor		Proportion healthy/sick		Ilness gap healthy/sick	
	Low	High	Few rich	Few poor	Few sick	Few healthy	Big gap	Samll gap
s^*	-1.628	2.596	1.298	3.513	2.596	2.596	2.596	2.596
$q^G(s^*)$	3.228	5.404	4.675	5.745	5.404	5.404	5.404	5.404
s_1^*	-3.484	1.689	0.834	2.286	0.834	2.286	1.849	1.619
$q_1^G(s^*)$	2.448	4.889	4.428	5.224	4.428	5.224	4.978	4.85
s_2^*	-1.394	3.503	3.342	3.623	3.342	3.623	5.527	2.521
$q_2^G(s^*)$	1.644	4.191	4.089	5.161	4.089	4.269	3.306	4.528
s_3^*	-0.993	3.175	2.451	3.71	2.837	3.383	4	2.863
$q_3^G(s^*)$	2.593	4.825	4.387	4.269	5.163	4.441	4	5.137
s_4^*	-1.12	3.005	2.142	3.648	3.005	3.005	3.196	2.856
$q_4^G(s^*)$	2.72	4.995	4.464	5.408	4.995	4.995	4.804	5.144

s^* and $q^G(s^*)$ refer to the baseline (perfect information) case.
s_1^* and $q_1^G(s^*)$ refer to the assymetry of information scenario (solidarity or separating), when the health rich are treated in the public sector.
$^*s_2^*$, s_3^*, $q_2^G(s^*)$ and $q_3^G(s^*)$ refer to the solidarity scenario, when all the rich are opting out.
s_4^* and $q_4^G(s^*)$ refer to the separating contracts scenario, when all the rich are opting out.

Lemma 2.3.1

The first best level of quality is independent of the health status.

The optimal quality maximizes the valuation of care over its costs, $v_{ij}(q) - c_{ij}(q)$. Because valuation is defined as $v_{ij}(q) = \theta_i \phi_j(q)$, the following holds true: $v_{hj} = \theta_h \phi_j(q) = \theta_h \frac{v_{sj(q)}}{\theta_s}$. This leads to $\frac{v_{hj}(q)}{\theta_h} = \frac{v_{sj}(q)}{\theta_s}$.

$$\begin{aligned} q^*_{hj} &= \underset{q}{\text{argmax}}\ [v_{hj}(q) - \theta_h q] \\ &= \underset{q}{\text{argmax}} \left[(v_{hj}(q) - \theta_h q) \left(\frac{\theta_s}{\theta_h} \right) \right] \\ &= \underset{q}{\text{argmax}}\ [v_{sj}(q) - \theta_s q] \\ &= q^*_{sj} \end{aligned}$$

Lemma 2.3.2

Under perfect competition, and no asymmetric information, private providers offer a fair premium and the first best quality for the rich.

Because of perfect competition, the zero-profit condition applies. This leads to, under perfect competition,

$$\Pi = P(q) - c(q) = 0$$

This implies fair premium.

Because of fair premium, any contract that does not maximize the surplus of quality over its costs will be suboptimal, and no agent will be interested in it. Only q^*_j can be offered. Because only the rich have access to the private market, only q^*_r can be supplied.

Lemma 2.3.3

Under fair prices, without asymmetric information, the minimum quality the rich individuals are accepting from the public sector $\underline{q}^G_{ir}$ is independent from the health status, $\underline{q}^G_{hr} = \underline{q}^G_{sr}$.

$\underline{q}^G_{hr}(s)$ and $\underline{q}^G_{sr}(s)$ are implicitly defined by the functions:

$$\begin{aligned} F^1(\underline{q}_{hr}^G, s) &= v_{hr}(\underline{q}_{hr}^G) - v_{hr}(q_r^*) + \theta_h(q^* - s) = 0 \\ F^2(\underline{q}_{sr}^G, s) &= v_{sr}(\underline{q}_{sr}^G) - v_{sr}(q_r^*) + \theta_s(q^* - s) = 0 \end{aligned}$$

Then, using as in Lemma 2.3.1 the condition that $\frac{v_{hj}(q)}{\theta_h} = \frac{v_{sj}(q)}{\theta_s}$:

$$\begin{aligned} F^1(\underline{q}_{hr}^G, s) &= v_{hr}(\underline{q}_{hr}^G) - v_{hr}(q_r^*) + \theta_h(q^* - s) \\ &= \left[v_{hr}(\underline{q}_{hr}^G) - v_{hr}(q_r^*) + \theta_h(q^* - s)\right]\left(\frac{\theta_s}{\theta_h}\right) \\ &= v_{sr}(\underline{q}_{sr}^G) - v_{sr}(q_r^*) + \theta_s(q^* - s) \\ &= F^2(\underline{q}_{sr}^G, s) \end{aligned}$$

Proposition 2.3.4

Under perfect risk selection and no subsidy, with public budget in a middle range ($B_1 < B < B_2$), part of the rich individuals are getting insurance in the private sector and the other part are getting care from the public sector. This means that $N^P < N_{hr} + N_{sr}$ and $N^G > N_{hp} + N_{sp}$. The quality in the public sector is equal to $\underline{q}_{ir}^G$.

If $B > B_1 = \underline{q}_{ir}^G(N_{hp} + N_{sp})$, and only the poor are supplied by the public sector, then $q^G = \frac{B}{N_{hp}+N_{sp}} > \underline{q}_{ir}^G$. This induces rich to enter the public sector.

If $B < B_2 = \underline{q}_{ir}^G N$ and all the population (rich and poor) are supplied in the private sector, then $q^G = \frac{B}{N} > \underline{q}_{ir}^G$. This induces rich to opt out for the private sector.

Therefore, for $B_1 < B < B_2$, using the fact that poor cannot opt out, there is necessarily a fraction of the rich in each sector, $N^P < N_{hr}+N_{sr}$ and $N^G > N_{hp}+N_{sp}$.

To maintain only a fraction of the rich in the both sectors, rich have to be indifferent between both sectors. From their indifference condition 2.5, $q^G = \underline{q}_{ir}^G$

Lemma 2.4.1

Under perfect risk selection and no assymetry of information, it is always cheaper for the public sector to subsidize the rich so that they opt out for the private sector rather than treating them directly.

The subsidy needed to induce the rich to opt out is such that

$$v_{ir}(q^G(s)) = v_{ir}(q_r^*) - \theta_i(q_r^* - s)$$

The definition of first best quality q_r^* implies that,

$$v_{ir}(q_r^*) - \theta_i q_r^* \geq v_{ir}(q^G(s)) - \theta_i q^G(s)$$

Combining these equations implies

$$\begin{aligned} v_{ir}(q_r^*) - \theta_i q_r^* &\geq v_{ir}(q_r^*) - \theta_i(q_r^* - s) - \theta_i q^G(s) \\ \theta_i q^G(s) &\geq \theta_i s \end{aligned}$$

Strict inequality is ensured for $q^G(s) \neq q_r^*$. The budget condition $B < q_p^* N$ and the assumption that $v_{ir}(q) > v_{ip}(q)$ ensure it.

Lemma 2.4.2

The minimum acceptable quality in the public sector $\underline{q}_{ir}^G(s)$ increases with s at an increasing rate, $\frac{\partial \underline{q}_{ir}^G(s)}{\partial s} > 0$, and $\frac{\partial \underline{q}_{ir}^G(s)^2}{\partial^2 s} > 0$.

$\underline{q}_{ir}^G(s)$ is implicitly defined by

$$F^3(\underline{q}_{ir}^G, s) = v_{ir}(\underline{q}_{ir}^G) - v_{ir}(q^*) + \theta_i(q_r^* - s) = 0$$

The implicit function theorem and the assumptions that $\frac{\partial v_{ij}(q)}{\partial q} > 0$ and $\frac{\partial^2 v_{ij}(q)}{\partial q^2} < 0$ imply that

$$\begin{aligned} \frac{\partial \underline{q}_{ir}^G(s)}{\partial s} &= \frac{-\frac{\partial F^3(\underline{q}_{ir}^G, s)}{\partial s}}{\frac{\partial F^3(\underline{q}_{ir}^G, s)}{\partial \underline{q}_{ir}^G}} = \frac{\theta_i}{v_{ir}(\underline{q}_{ir}^G(s))'} > 0 \\ \frac{\partial^2 \underline{q}_{ir}^G(s)}{\partial s^2} &= \underbrace{-\theta_i}_{<0} \underbrace{\left[v_{ir}\left(\underline{q}_{ir}^G(s)\right)'\right]^{-2}}_{>0} \underbrace{v_{ir}(\underline{q}_{ir}^G(s))''}_{<0} > 0 \end{aligned}$$

Proposition 2.4.3

Under perfect risk selection, a subsidy s^*, defined as $\underline{q}_{ir}^G(s^*) = q_p^G(s^*)$, maximizes the objective function of the government. For $s^* > 0$, it is also an improvement in a Pareto sense over the no subsidy case

The maximization program of the government is as follows

$$max_s q^G(s)$$
$$s.t. \quad q^G(s) \leq \underline{q}_{ir}^G(s)$$
$$q^G(s) \leq q_p^G(s)$$

Because of lemma 2.4.2 (MAQ increases with s) and the fact that $q_p^G(s)$ decreases linearly with the subsidy s, $\underline{q}_{ir}^G(s)$ and $q_p^G(s)$ have a single crossing point, $(s, q^G(s))$. The maximum attainable q^G is the crossing point.

If $s^* > 0$ maximizes the objective function of the government, $q^G(s^*) > q^G(0)$. The poor are better off. Because the utility of the rich is identical, irrespective of the sector the seek care from (from the MAQ), an increase in public quality q^G is also beneficial for them. If the optimal subsidy is positive, it is an improvement in a Pareto sense.

Lemma 2.4.4

Under a solidarity policy, the minimum acceptable qualities $\underline{q}_{hr}^{G[1]}(s)$ and $\underline{q}_{hr}^{G[2]}(s)$ in the public sector for the healthy rich are increasing and convex in s. At any subsidy level s, we have that $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^{G[1]}(s) > \underline{q}_{hr}^{G[2]}(s)$.

$\underline{q}_{hr}^{G[1]}(s)$ is implicitly defined by

$$F^4(\underline{q}_{hr}^{G[1]}, s) = v_{hr}(\underline{q}_{hr}^{G[1]}) - v_{hr}(q_r^*) + \frac{N_{sr} + N_{hr}}{M_{sr} + M_{hr}}(q_r^* - s) = 0$$

The implicit function theorem and the assumptions that $\frac{\partial v_{ij}(q)}{\partial q} > 0$ and $\frac{\partial^2 v_{ij}(q)}{\partial q^2} < 0$ imply the result as in Lemma 2.4.2.

$\underline{q}_{hr}^{G[2]}(s)$ is implicitly defined by

$$F^5(\underline{q}_{hr}^{G[2]}, s) = v_{hr}(\underline{q}_{hr}^{G[2]}) - v_{hr}(q_r^*) + \theta_s(q_r^* - s) = 0$$

The implicit function theorem and the assumptions that $\frac{\partial v_{ij}(q)}{\partial q} > 0$ and $\frac{\partial^2 v_{ij}(q)}{\partial q^2} < 0$ imply the result as in Lemma 2.4.2.

From Lemma 2.3.3, $\underline{q}_{sr}^G = \underline{q}_{hr}^G$ where $\underline{q}_{hr}^G$ is defined in the perfect information (baseline) setting, implicitly from $F^1(\underline{q}_{hr}^G, s) = v_{hr}(\underline{q}_{hr}^G) - v_{hr}(q_r^*) + \theta_h(q^* - s) = 0$. Because $\theta_h < \frac{N_{sr}+N_{hr}}{M_{sr}+M_{hr}} < \theta_s$, and because $\frac{\partial v_{ij}(q)}{\partial q} > 0$, we have $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^{G[1]}(s) > \underline{q}_{hr}^{G[2]}(s)$.

Proposition 2.4.5

There are two potential equilibria, at s_1^*, where the healthy rich are in the public sector, and s_3^*, where all the rich are opting out. If and only if $\underline{q}_r^{G[1]}(s_3^*) \geq \underline{q}_{sr}^G(s_1^*)$, then s_3^* is Pareto dominating s_1^*.

If only the sick rich are in the private sector, the maximization program of the government is as follows

$$\begin{aligned} & max_s q^G(s) \\ & s.t. \quad q^G(s) \leq \underline{q}_{sr}^G(s) \\ & \qquad\; q^G(s) \leq q_h^G r(s) \end{aligned}$$

Because of lemma 2.4.2 (MAQ increases with s) and the fact that $q_{hr}^G(s)$ decreases linearly with the subsidy s, $\underline{q}_{sr}^G(s)$ and $q_{hr}^G(s)$ have a single crossing point, $(s, q^G(s))$. The maximum attainable q^G is the crossing point.

If all the rich (healthy and sick) are in the private sector, the maximization program of the government is as follows

$$\begin{aligned} & max_s q^G(s) \\ & s.t. \quad q^G(s) \leq \underline{q}_{hr}^{G[1]}(s) \\ & \qquad\; q^G(s) \leq q_p^G(s) \end{aligned}$$

Because of lemma 2.4.4 (MAQ increases with s) and the fact that $q_p^G(s)$ decreases linearly with the subsidy s, $\underline{q}_{hr}^{G[1]}(s)$ and $q_p^G(s)$ have a single crossing point, $(s, q^G(s))$. The maximum attainable q^G is the crossing point.

Poor are getting utility associated with public quality. The pivotal agents (healthy rich when they are getting private care, sick rich when healthy rich are getting public care) are getting the exact same utility out of the public and the private sector quality (indifference conditions). Sick rich are better off when subsidized (through risk pooling) by the healthy rich. Therefore, if $\underline{q}_r^{G[1]}(s_3^*) > \underline{q}_{sr}^G(s_1^*)$, an equilibrium where the healthy rich are subsidizing the sick rich, at subsidy s_3^*, is Pareto dominant.

Lemma 2.4.6

Under risk selection with assymetric information, the sick rich are getting their first-best level of quality, q_r^* at a fair premium $P(q_{sr}) = \theta_s(q_r^* - s)$. The healthy rich are getting quality $\overline{q}_{hr}(s)$ at a fair premium $P(q_{hr}) = \theta_h(\overline{q}_{hr}(s) - s)$. The decrease in *quality incurred by the healthy rich to signal themselves as good risks is reduced by the subsidy.*

At quality level $\overline{q}_{hr}(s)$ and fair premium $P(\overline{q}_{hr}(s)) = \theta_h(\overline{q}_{hr}(s) - s)$ (in the private sector), we have the following incentive compatibility constraints

$$\begin{aligned} v_{sr}(\overline{q}_{hr}(s)) - \theta_h(\overline{q}_{hr}(s) - s) &\leq v_{sr}(q_r^*) - \theta_s(q_r^* - s) \\ v_{hr}(q_r^*) - \theta_s(q_r^*) &\leq v_{sr}(\overline{q}_{hr}(s)) - \theta_h(\overline{q}_{hr}(s) - s) \end{aligned}$$

Healthy rich are buying the contract $(\overline{q}_{hr}(s), P(\overline{q}_{hr}(s)))$, and are not interested in $(q^*, \theta_s(q^* - s))$.

Sick rich are not interested in $(\overline{q}_{hr}(s), P(\overline{q}_{hr}(s)))$ if their optimal contract $(q^*, \theta_s(q^* - s))$ is available. Because of competition in contracts, a pooling contract cannot be a stable equilibrium.

$\overline{q}_{hr}(s)$ is implicitly defined by

$$F^6(\overline{q}_{hr}, s) = v_{sr}(\overline{q}_{hr}) - \theta_h(\overline{q}_{hr} - s) - v_{sr}(q_r^*) + \theta_s(q_r^* - s) = 0$$

The implicit function theorem and the assumptions that $\frac{\partial v_{ij}(q)}{\partial q} > 0$ and $\frac{\partial^2 v_{ij}(q)}{\partial q^2} < 0$ together with $\theta_h < \theta_s$ imply that

$$\begin{aligned} \frac{\partial \overline{q}_{hr}(s)}{\partial s} &= \frac{-\frac{\partial F^6(\overline{q}_{hr}, s)}{\partial s}}{\frac{\partial F^6(\overline{q}_{hr}, s)}{\partial \overline{q}_{hr}}} = \frac{-(\theta_h - \theta_s)}{v_{sr}(\overline{q}_{hr}(s))' + \theta_h} > 0 \\ \frac{\partial^2 \overline{q}_{hr}^G(s)}{\partial s^2} &= \underbrace{(\theta_h - \theta_s)}_{<0} \underbrace{[v_{sr}(\overline{q}_{hr}(s))' + \theta_h]^{-2}}_{>0} \underbrace{v_{sr}(\overline{q}_{hr}(s))''}_{<0} > 0 \end{aligned}$$

Lemma 2.4.7

Under risk selection with assymetric information, the minimum acceptable quality in the public sector for the healthy rich is increasing with s at an increasing rate, $\frac{\partial \underline{q}_{hr}^G(s)}{\partial s} > 0$. *Healthy rich are pivotal,* $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^G(s)$

$\underline{q}_{hr}^G(s)$ is implicitly defined by

$$F^7(\underline{q}_{hr}^G, s) = v_{hr}(\underline{q}_{hr}^G) - v_{hr}(\overline{q}_{hr}(s)) + \theta_h(\overline{q}_{hr}(s) - s) = 0$$

The implicit function theorem and the assumptions that $\frac{\partial v_{ij}(q)}{\partial q} > 0$ and $\frac{\partial^2 v_{ij}(q)}{\partial q^2} < 0$, together with Lemma 2.4.6 imply that

$$\frac{\partial \underline{q}_{hr}^G(s)}{\partial s} = \frac{-\frac{\partial F^7(\underline{q}_{hr}^G, s)}{\partial s}}{\frac{\partial F^7(\underline{q}_{hr}^G, s)}{\partial \underline{q}_{hr}^G}} = \frac{(v_{hr}(\overline{q}_{hr}(s))' - \theta_h)\frac{\partial \overline{q}_{hr}(s)}{\partial s} + \theta_h}{v_{hr}(\underline{q}_{hr}^G(s))'} > 0$$

From Lemma 2.3.3, $\underline{q}_{sr}^G = \underline{q}_{hr}^G$ where $\underline{q}_{hr}^G$ is defined in the perfect information (baseline) setting, implicitly from $F^1(\underline{q}_{hr}^G, s) = v_{hr}(\underline{q}_{hr}^G) - v_{hr}(q_r^*) + \theta_h(q^* - s) = 0$. Because $v_{hr}(q_r^*) - \theta_h(q^* - s) > v_{hr}(\overline{q}_{hr}(s)) - \theta_h(\overline{q}_{hr}(s) - s)$, and because $\frac{\partial v_{ij}(q)}{\partial q} > 0$, we have $\underline{q}_{sr}^G(s) > \underline{q}_{hr}^G(s)$.

Proposition 2.4.8

There are two potential equilibrium, at s_1^*, where the healthy rich are in the public sector, and s_2^*, where all the rich are opting out. If and only if $\underline{q}_{hr}^G(s_2^*) \geq \underline{q}_{sr}^G(s_1^*)$, then s_2^*, where the healthy rich are participating in the private market, is Pareto dominating s_1^*, where the healthy rich are receiving public care.

If only the sick rich are in the private sector, the maximization program of the government is as follows

$$
\begin{aligned}
& max_s q^G(s) \\
& \quad s.t. \quad q^G(s) \leq \underline{q}_{sr}^G(s) \\
& \qquad\qquad q^G(s) \leq q_h^G r(s)
\end{aligned}
$$

Because of lemma 2.4.2 (MAQ increases with s) and the fact that $q_h^G r(s)$ decreases linearly with the subsidy s, $\underline{q}_{sr}^G(s)$ and $q_h^G r(s)$ have a single crossing point, $s, q^G(s)$. The maximum attainable q^G is the crossing point.

If all the rich (healthy and sick) are in the private sector, the maximization program of the government is as follows

$$
\begin{aligned}
& max_s q^G(s) \\
& \quad s.t. \quad q^G(s) < \underline{q}_{hr}^G(s) \\
& \qquad\qquad q^G(s) < q_p^G(s)
\end{aligned}
$$

Because of lemma 2.4.7 (MAQ increases with s) and the fact that $q_p^G(s)$ decreases linearly with the subsidy s, $\underline{q}_{hr}^G(s)$ and $q_p^G(s)$ have a single crossing point, $s, q^G(s)$. The maximum attainable q^G is the crossing point.

Chapter 3

Sex, drugs and rock'n roll: The effect of education on health behavior

3.1 Introduction

The high correlation between education and health has been largely documented. Nonetheless, a causal effect of education on health has been harder to prove. The relationship between education and mortality has been studied in the United States by Lleras-Muney (2005) [26], in France by Albouy and Lequien (2008)[2], in the Netherlands by van Kippersluis et al. (2009) [35], in the United Kingdom by Clark and Royer (2008) [15]. Lleras-Muney and Kippersluis et al. claim to have found that education delays mortality in a significant manner while Alvouy and Clark do not. This may be due to the different interactions of education with the national health system in each country and the specific educational improvements of the reform.

Education may directly or indirectly affect health outcomes. A direct effect would be through health behavior. Better educated people have greater means to evaluate risk and make the necessary changes in their lifestyle. The indirect channel is through income. Wealthier people can afford more and better services that have a positive impact on health. For instance, richer individuals can afford better health care; especially in health care systems largely financed by out of pocket expenditure.

Educational reforms have proved to be good instruments to test the causal impact of education on several outcomes. In labor economics, educational reforms have been traditionally used to measure the effect of education on workers' wages. In health economics those reforms have been used mainly to measure the impact on health outcomes. The educational reforms are considered exogenous, pushing a large part of the population to extend their life school years. In the health economics literature, most of the reforms that have been used as instruments were implemented during the first half of the twentieth century while the observed effects are measured in general more than 50 years later. This allows testing the consequences of education on late health outcomes but it is affected by survival bias, as those who were not healthy enough to live up to certain age are not in the sample. The estimated effect of education can be considered as a lower bound if the effect of education is assumed to be the same among all health groups.

In contrast with previous studies, I use a much more recent educational reform, namely the one that took place in Mexico in 1993, which extended the compulsory school years from six to nine. Data were collected a in subsequent survey in 2005; this is nine years after the reform was implemented. This fact allows shedding some light on the causal effect of education on health behavior (sexual behavior and tobacco use) during adolescence.. Those estimations are not affected by survival bias, given the negligible mortality rate of young people.

This paper is organized as follows: in section two I start with a discussion on the effect of education on health outcomes. Then, section three introduces the Mexican educative system and its developments, putting special emphasis on the 1993 Educational Reform. Section four describes the two data sets. Section five presents the methodology and the estimations. Finally in section six I discuss the findings.

3.2 Education and health

The first challenge to study the relationship between education and health comes from properly defining what we understand for health. Health is a broad concept; it is not a one dimensional variable. Basically, we can distinguish three categories: self assesed health, health outcomes and health behavior. Self assesed health incorporates several aspects of health but is a subjective measure. Health outcomes and health behavior are much more robust in terms of objectivity but more difficult to integrate in a single index. Health outcomes are concrete states of health that are influenced by health behavior and access to health care.

One of the earliest contributions to study the causal relationship between schooling and health comes from Berger and Leigh (1989)[7]. They use the Examination Survey I and the National Longitudinal Survey of Young Men in the USA to study the impact of education on blood pressure and activity limitations. Education is instrumented as a per-capita state expenditure on education. They find a significant positive causal effect of education on reducing high blood pressure and activity limitations.

Adams (2002)[1], using a sample of over 24,000 observations from the Health and Retirement Study in the USA, studies several kinds of activity limitations for individuals between 51 and 60 years old. His estimations are instrumented by changes on compulsory schooling laws and people's date of birth. He also finds a positive causal effect of education in the reduction of most ot the activity limitations that he considers.

Doyle et al (2005) [16] inquire on the effect of parents' education on their childrens' health in the United Kingdom. They also use changes on compulsory education laws as an instrument for education. They do not identify a positive effect of education on children's health. Arendt (2005) [3] looks at self reported health and chronic health conditions as health measures and uses the 1958 and 1975 educational reforms. He cannot identify a causal effect of education on those health measures.

More recent studies have analyzed the causal effect of education on mortality. Albouy & Leqien 2009 [2] and van Kippersluis et al. 2009 [35] are the two most recent studies that have used individual data rather than cohort size which provides a more robust result. Despite using similar methodology their conclusions are on the opposite direction. Albouy & Lequien 2009 do not find a significant decrease in mortality for adults between 50 and 80 years old in France while van Kippersluis et al. 2009 do find a causal effect of education on reducing mortality risk on males between 80 to 88 years old in the Netherlands.

One of the disadvantages of using mortality to analyze the effect of education on health is that it may be sensitive to survival bias. Further, there is huge time span between the given treatment and observed outcome. So, if we want to analyze an immediate impact of education on health, mortality is not a good candidate. Health behavior can be a more sensitive measure. Medical studies have shown that health outcomes are highly influenced by health behavior. To analyze this relationship, I am using health behavior to measure the effect right after the given treatment. This analysis considers one additional education after the 6th year of primary school as a treatment. The two aspects in health behavior I am measuring is sexual behavior and smoking during adolescence.

Education may be seen as an amount of information that it is transmitted to individuals so testing the causal effect of education on health behavior is similar to test individual reaction to information on the adoption of healthy life style. If there is a causal effect of education on health behavior then informative campaigns about the benefits of a healthy life style should be highlighted. On the contrary, if there is no causal effect, then there would be a greater need to rely on alternatives policies to influence health behavior through higher taxes on cigarettes and smoking bans.

3.2.1 Sexual Behavior

Risky sexual behavior during adolescence can lead to venereal diseases and teen pregnancy which may damage psychological and physical development of the individual. Latin America and the Caribbean region reports very high rates of teen pregnancy even though current total fertility rate is at 2.21 which is very close to replacement level. Countries such as Brazil, Chile and Costa Rica report more than 60 life births per 1000 women aged 15-19. This is a figure is 8 times greater than in Western Europe. Mexico teen fertility rate is at 65 life births per 1000 women aged 15-19, which is not very different from the regional average at 73.

In Mexico, one in six life births take place on women younger than 20 years old. Teen pregnancy imposes a great social and economic cost, not only for the young parents but also in the new born child. There exists a strong correlation between mother aged below 20 years at first birth (MAFB-20) and child poor school performance; between MAFB-20 and adolescent criminality. Although this is simply a correlation there are some elements that make us suspicious that this relationship could be at least partially causal.

A better understanding of the impact of education on sexual behavior can shed light on the complexity behind teen pregnancy. For instance, if education does not have a causal effect on sexual behavior, then it would be worth to concentrate more resources in campaigns directed to parents to prevent teen pregnancies. In contrast, if education has a causal effect on sexual behavior then programs targeted to adolescents may prove to be more cost effective.

3.2.2 Tobacco use

Adolescent smoking is particularly interesting as a health risk behavior. It is highly addictive which makes that those who start smoking at early age remain smokers for a long period of time. Tobacco is considered as a gateway to other drugs. This means that adolescent smokers are more likely to begin drinking alcohol and using illicit drugs than non-smoking adolescents.

3.3 The Mexican Educational System and its 1993 Reform

The Mexican educative system is organized as follows: *Primary school* comprehends the first six years of formal education (from six to 12 years old) and is followed by three years of *secondary school* (12-15). Then, before entering university, students follow three more years of *preparatory school* (15-18).

Although the first compulsory schooling law in Mexico was implemented as early as in 1867, it took around 80 years to have a first Census (1950) showing that more than 50 percent of the Mexican population was literate. Until 1920, the scarce existing schools were mainly concentrated in a few cities in a country with an overwhelming rural population at that time. With the creation of the Ministry of Public Education in 1921 and the beginning of a long lasting peaceful period, the basic education network improved significantly. At the same time, a very drastic demographic transition started, with record high population growth rates from the 1950s to the mid 1970s. This made the coverage of the increasing demand for education more difficult. However, the percentage of the population from 6 to 24 years old attending to school grew from 27.73 to 48.17 per cent from 1950 to 1970[1].

In the 1960s *primary* education was widely available nationwide with a relatively high enrollment rate. On the other hand, *secondary* education enrollment rate was much lower and it was mainly confined to urban areas. A large part of the 6th grade primary students did not continue with secondary education. In order to cope with a lack of infrastructure, in 1969 a *tele-secondary* school system was introduced in rural areas. This system consisted of an instructor supported by audiovisual material aired on national television channels.

A significant milestone in the secondary school system was reached by the Minister of Education in 1974, known as the Chetumal Resolution. This resolution set the curricular secondary education program that was valid until 1993 and aimed to encourage students to continue their education after conclusion of *primary school*. In 1977 there was a first attempt to introduce a mandatory secondary school law. The initiative failed to be approved by the Congress in a debate that judged the initiative as unrealistic or too early to be applied. In the 1980s the Mexican economy suffered from two major economic crises (1982 and 1986) which made it impossible to retake the 1977 initiative.

In the early 1990s the economy stabilized and more credible democratic institutions emerged. Also the state budget was in good shape since there were funds generated from a privatization process of several state firms. Those three factors

[1]Administrative data, Secretaria de Educacion Publica.

created a favorable environment for the 1993 educative reform to prosper, making secondary education mandatory and increasing the secondary education infrastructure to meet the new demand.

The reform was approved in March 1993 and published the official journal in June the same year. It took real effect on students who were 12 year old or younger in September 1993. The number of students attending secondary school stagnated at around 4.2 million from 1989-90 to 1992-93 school years and exceeded 4.8 million in the fourth year after the reform 1996-97. This is an increase of over 3 percent per year in a segment of the population which was growing below 0.5 percent.

The reform benefited from the agreement of different political actors like the teachers' union and the opposition parties. Education Minister at that time, Mr. Ernesto Zedillo, was largely credited for the reform and next year he became the presidential candidate for the ruling party, winning the general elections in 1994.

3.4 Data

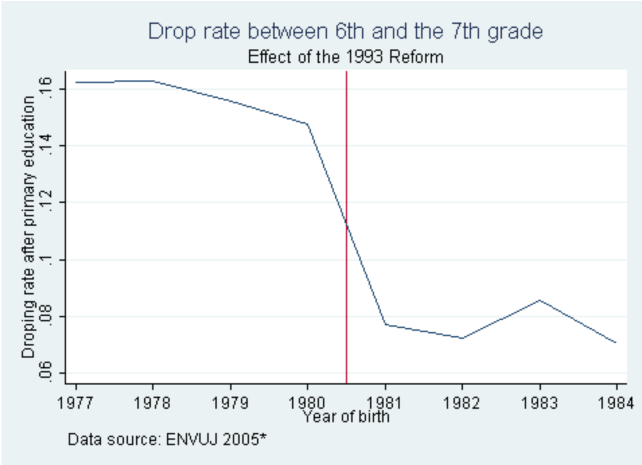
The National Youth Survey (ENJUV 2005) in Mexico is a longitudinal dataset with observations on 12,796 individuals aged 12 to 29 years. The survey was carried out by the Mexican Institute of Youth in cooperation with the National Autonomous University of Mexico and the Ministry of Public Education in October 2005.

From the 12,796 individuals captured in the survey I take a subsample of those who were born between 1977 and 1984. Figure 3.1 shows the dropout rate at the end of primary school by birth cohort (1977 to 1984). It can be seen a discontinuous drop between the 1980 and 1981 cohorts which it is presumed to be the effect of the 1993 reform.

The aim of ENJUV 2005 was to provide information about education, health, sexuality, private life attitudes and values of the teenagers and young adults through a questionnaire of more than 200 questions divided in 9 sections. A key question was condom use during the first sexual intercourse (FSI) and the age of the FSI. These two variables allow us to construct a group of dependent variables that describe sexual behavior.

The variables that are built from those questions are: *No sex* valued one if the individual did not have a sexual intercourse during the age of 15 to 19 and zero otherwise; *Sex without condom* valued one if the individual had a FSI without condom use. The reason to focus on the FSI is that there is a very high rate of no condom use during the FSI. It can be observed that, as teenagers gain more sexual experience, the likelihood of using contraceptive measures increases. Also looking to a simple descriptive data of ENJUV 2005 we find out that among individuals

Figure 3.1: Effect of the 1993 Reform on the drop rate



who started their active sexual life between 15-19,those who reported condom use in their FSI had 75 per cent less chances to become parent during adolescence.

The other relevant question is the age at which they started smoking if ever smoked. From this question I construct the dependent variable *smoke* which is valued one if the individual reported to have started smoking between 14 and 19 years old.

The explanatory variable that is of main interest for this paper is education and this is captured through the variable *Dropping after PS*. This variable is valued one if the individual stoped studying after the sixth school year (primary school) and zero if he/she continued. Note that only individuals who finished the sixth grade of school are taken into consideration (in the sample). The reason is that the reform that serves as an instrument affects theose individuals who may drop out after completing primary school and not in those who already left school before. Additionally, education is measured as a dichotomous variable , to avoid potential reverse causality in case that becoming parents influences the decision to stop schooling. This way we make sure that we first give the treatment and then we observe the behavior.

The rest of the control variables are: demographics, *female* and *indigenous*, socioeconomic index (which may be low, middle and high), *Family problems* (which is valued one if the individual grew up with a single parent or faced alcohol abuse from one of his parents) and social clusters which tend to control for social networks which may influence health behavior. The two social clusters are self identification as *religious* person and declared to prefer *rock music* (top two music type). Finally there is a group of variables that classify the place of residence. The variable*Big city* refers to the individual living in Mexico City, Guadalajara or Monterrey, the three largest metropolitan areas.

Tables 3.1 and 3.2 show the descriptive statistics of sexual behavior and tobacco use. The number of observations is not exactly the same in both tables because there are a few respondents that did not completely answer one section but did to the other. For sexual behavior individuals who had a FSI at 14 years old or younger are excluded from this sample in the same manner that individuals who start smoking before 14 years old are excluded from the tobacco sample. This is because if they have already changed their behavior before the treatment then we cannot expect any effect from it.

3.5 Estimation

There are two separate analysis of health behavior during adolescence in this paper. First, I discuss the effect of education on sexual risk behavior and then, in a separate subsection, the impact of education on smoking. By using ENJUV 2005 data it is possible to identify the effect of the 1993 educational reform on a sample of men and women and on a subsample of women only.

The main danger on adolescents' sexual behavior is having an unprotected sex, representing a high risk for sexual transmissible diseases and unwanted pregnancies. ENJUV 2005 does not dispose information on ever having an unprotected sexual intercourse during adolescence. The survey has data on whether or not individuals report condom use during their FSI and how old they were, if they ever had sex. Based on this information there are three possible outcomes. First, the respondent did not have a sexual intercourse during adolescence. Second, the respondent did have sex but his/her FSI was with condom use. Third, the respondent did have sex and did not report condom use in his/her FSI. If the individual used condom during the FSI it is very likely that he/she does the same in his/her subsequent sexual engagements. Nevertheless, it cannot be regarded as zero risk of having unprotected sex during adolescence if they use condom in the FSI.

I use the 1993 reform as an instrument to control for unobserved characteristics that may bias the estimators. First, I will present OLS and Probit estimations for *no sex*, *sex without condom use* independently, then I estimate the probability of *sex without condom use* conditional on having sex. Second, I show the causal effect of education for each equation with IV and biprobit estimation procedures. Although, it could be appropriate to try also more sophisticated estimation strategies yet as the sample size is not big enough I have to rely on the standard estimation methods.

In the tobacco analysis I follow the same logic. First I show the non causal relationship then I use the reform to analyze the causal effect.

3.5.1 Correlation between health behavior and education

Sexual behavior

Tables 3.4 to 3.6 show the non causal relationship between sexual behavior and the covariates for men and women combined. In each table the first column shows the OLS linear probability model estimation; the second column shows the Probit estimation and the third column shows the Probit marginal effect. We can observe that there are no contradicting signs and the Probit marginal effect is close to the OLS estimation. Table 3.7 shows a similar analysis only for a subsample of women.

The most risky sexual behavior for an adolescent is having started sexual live without condom use. Table 3.5 shows the unconditional probability of having a FSI during adolescence (15-19 yrs old) without condom use. Dropping school between the 6th and 7th grade significantly ($p < 0.01$) increases the risk of having FSI without condom use adding 7.7 percentage points to the base probability. Again, this is not a causal effect but this correlation is not negligible.

The other covariates that are statistically significant on the equation of having a FSI without condom use are *female*, middle, high socioeconomic index, *rock music*, *urban* and *Center West* region. For women the probability of having a FSI without condom use is ($p < 0.01$) 19 percentage points higher than men. Adolescents from more favorable socioeconomic households have lower risk. Middle ($p < 0.1$) and high ($p < 0.01$) socioeconomic index have 5 and 15 percentage points lower probability than low socioeconomic households of having a FSI without condom use. Rock music lovers have lower risk, ($p < 0.1$). As expected, urban areas have a lower risk (8.4 percentage points less, $p < 0.01$) than the rural one. The most relevant geographical difference is the *Center West* residents, having 9.8 percentage points less on the probability ($p < 0.01$) than those of the South.

Table 3.4 shows the probability of having sex versus not having sex. Dropping school at the end of primary school is estimated to reduce the probability of not having sex by 3 percentage points but it is not statistically significant from zero.

Positive and statistically significant covariates of not having sex during adolescence are: *female* with 16.4 percentage points less to the base probability ($p < 0.01$), indigenous with 9.5 percentage points ($p < 0.05$), high socioeconomic index with 7 percentage points ($p < 0.05$), *religious* with 4 percentage points ($p < 0.05$) and living on the *Center West* region, which is well known to be the most conservative region of the country, 5.7 percentage points (vs South region base).. In contrast, *urban* residence and family problems reduce the probability of not having sex in about 6.6 and 5.6 per cent respectively in a significant manner ($p < 0.01$). All these signs are as expected, except for indigenous.

Table 3.6 shows the probability of having sex without condom conditional on having sex. Dropping school at the end of primary school increases the probability of having sex without condom by 11 percentage points ($p < 0.01$) conditional on having sex.

The other covariates which are statically significant are female, which increases the probability by 20 percentage points ($p < 0.01$). Middle and high SI, rock music, urban and Center West region decrease the probability between 5 and 16 percent and are statistically significant.

In summary, from tables 3.4 to 3.6 we can conclude that passing from the sixth to the seventh grade has a favorable effect on condom use if having a sexual active life during adolescence. There is not statistically significant evidence that there is an increased sexual activity during adolescence due to education. Moreover looking at the unconditional probability of having sex without condom use education significantly reduces this risk. Table 3.7 shows the same analysis only for the women's sample with a very similar pattern except for the intercept. The effect of education goes in the same direction for both samples.

Tobacco

Table 3.13 presents the probability of start smoking between 14 to 19 years old. For both groups men and women combined and women only, education is significant ($p < 0.01$) and positively correlated with smoking. This may sound a bit counterintuitive if we think that better educated people may be more aware of the damage caused by smoking. Dropping out of school at the sixth grade reduces the probability of smoking by 6 to 7 percent. Nevertheless, peer pressure or some unobservable factors may be driving this result.

Other covariates that positively and significantly increase the propensity to smoke are *family problems*, *rock music*, *urban*, *big city* and *Central region*. Females had a significantly ($p < 0.01$) lower propensity to smoke than males.

3.5.2 Causal effect of education on health behavior

The effect of the educational reform is statistically significant, validating its use as an instrument for the estimations. The F-test for a valid instrument passes the criteria proposed by Stock and Yogo 2002. Nevertheless, as expected, the standard errors in the IV estimation are bigger so I focus more on the sign rather than on the magnitude. In fact, some effects are too big but if we consider a 10 percent lower bound, the effect may be reasonable. The magnitude of the effect may be due to the imprecision of high standard errors.

Sexual behavior

The main results of the causal effect of education on sexual behavior are summarized on table 3.9 corresponding IV estimation method. The first column shows the estimation of not having sex, the second column shows the unconditional probability of having sex without condom use and the third column shows the probability of having sex without condom conditional on having sex. Additionally, table 3.10 shows a bivariate Probit estimation method which presents very similar result s to the IV estimation. The coefficients need to be converted into marginal effects to be comparable. Table 3.12 and 3.11 present also a IV estimation, the first one considering just the cohorts of 1979-1982 and the second one for the cohorts of 1977-1984 but correcting for a time trend. In fact, the estimations are also similar to the IV but due to bigger standard errors the coefficients are statistically less significant. Table 3.8 shows a similar analysis only for a subsample of women but coefficients are not statistically significant.

From 3.9 we conclude that dropping out of school has a significant and positive impact on not having sex during adolescence ($p < 0.1$) which may suggest that peer pressure has some impact on sexual behavior. Most of the covariates have the same sign than in the no causal estimation but significant levels are much lower. *Female*, *indigenous*, *family problems*, *religious*, *urban* and *Center West region* are still significant with the same signs than before.

The causal estimation of the effect of education on the probability of having a FSI without condom use is described in table 3.9, column two. Education has a protective effect to reduce the risk of having a sexual intercourse without condom use ($p < 0.01$). The covariates that are statistically significant are *female*, *indigenous*, *family problems* and *Center West* region.

The third column in table 3.9 shows the probability of condom use conditional on having a FSI. Dropping school between the sixth and seventh grade substantially reduces the risk of not using condom ($p < 0.05$) during the FSI conditional on having sex. The other significant covariates are *female*, with a positive contribution, and *indigenous*, *urban* residence and *Center West* region has a negative contribution.

Tobacco

Table 3.14 describes the IV estimation for tobacco use during adolescence. In the first column we observe that tobacco use is no longer significantly different from zero. The rest of covariates that were significant in table 3.13 are still significant and have the same sign in the first column of table 3.14 , which comprehends the sample of both men and women. In contrast, for the women only subsample, dropping after primary school still has a negative and significant impact on the probability of starting smoking during adolescence.

This result is very interesting; even though women have a lower probability to smoke overall, education has the opposite effect that I would expect. One possible interpretation is that education is effective in fighting prejudices between men and women. For low educated people, a woman smoking may be considered much worse than men smoking. For more educated people, smoking is bad but a woman smoking is not regarded much worse than a man smoking.

3.6 Discussion

There is evidence that education has an impact on health behavior although the effects are not always in the expected direction. The estimated effect of education is also influenced by adolescent's peer pressure. We could expect the effect of education on health behavior would more positive later in life.

For sexual health behavior the net effect of education is encouraging. Continuing studying from the sixth to the seventh grade significantly decreases the risk of having a FSI without condom use. Nevertheless, education also has a positive effect on initiating sexual life during adolescence. It is not clear if the increase of sexual activity is due to the exposure to sexual information at school or due to the concentration of young people. However the high sexual activity effect is overcome with a much higher probability of condom use if the adolescent has sex.

The socioeconomic index seems not to play a very important role once the causal effect of education on sexual behavior is controlled. Family problems, instead, increase significantly the probability of having sex without condom use. Social clusters do not play a determinant role once it has been controlled for the causal effect of education. Urban residence increases the probability of having sex but urban residents also report a higher condom use though the net effect cancels out.

The significant and positive correlation between smoking and education disappears once we control for the causal effect of education for the women and men group combined. Nevertheless for women only group we find a causal effect of education on smoking. This is not the first time in the literature that effect of education on women smoking is positive, previous studies have found at least this correlation especially in middle income countries. This may be interpreted as having fewer prejudices against sex stigma "women cannot do everything men can do". We observe that for more educated people in Mexico the female-male gap in smoking rate is reduced with education but mainly because women have a higher smoking rate. Nevertheless women smoking rate is much lower than men even for educated folks.

I have to precise that the variable ever smoke is quite broad and it would be interesting to look also to other measures like daily smoking since this has a stronger correlation with risky health behavior. We may think that educated people are aware that becoming a regular smoker represents a hazard for their health but just trying does not make them addict. However it is interesting to see that the advantage of having more information is offset by other effects surrounding young people.

There are two main limitations in this study. First, given that the number of observations for the cohort of interest is relatively small, the estimation suffers from big standard errors which make the estimation imprecise. Nevertheless, some effects are significant. The second limitation comes from the fact that data come from a survey and given the existence of some taboos, individuals might not be truly reporting their behavior.

Measuring the impact of education on health behavior shed light on people's reaction given a better understanding of health risks. This is relevant for policy makers aiming to induce healthier behaviors. Based on the results of this paper I would make different recommendations with respect to health risk. For instance, a better understanding of the health risk makes clear improvements in sexual behavior. In contrast, smoking shows a different scenario especially for women. The advantage of having more information about health risk is easily overcome by other factors, like peer pressure in secondary schools. For this reason, in order to discourage adolescent smoking I would rely more heavily on higher taxes and smoking bans in public places.

3.7 Appendix

Table 3.1: Descriptive statistics for sexual behavior

	Reform		
	No	Yes	Total
N	1617	1837	3454
Variable			
Sexual behavior			
No sex	0.4634	0.4925	0.4789
Sex without condom	0.354	0.3092	0.3302
Sex with condom	0.1826	0.1982	0.1909
Education			
Dropping after PS	0.1575	0.0764	0.1144
Demographics			
Female	0.6454	0.6185	0.6311
Age	26.4585	22.4409	24.3217
Indigenous	0.0422	0.0336	0.0376
S. economic index			
Middle	0.5985	0.6113	0.6053
High	0.1101	0.1229	0.1169
Family background			
F. Problems	0.3092	0.3092	0.3092
Social cluster			
Religious	0.3243	0.3464	0.3361
Rock music	0.1661	0.2246	0.1972
Residence			
Urban	0.7053	0.7269	0.7168
Big City	0.3349	0.3645	0.3506
Center	0.1608	0.1791	0.1706
North East	0.2736	0.2334	0.2522
North West	0.0389	0.0454	0.0424
Center West	0.3421	0.3521	0.3474
South, Sout Est	0.1846	0.19	0.1875

Table 3.2: Descriptive statistics for tobbaco use

	Reform		
	No	Yes	Total
N	1839	1630	3469
Variable			
Health behavior			
Smocking	0.2892	0.3121	0.3013
Education			
Dropping after PS	0.1576	0.077	0.1149
Demographics			
Female	0.6493	0.6241	0.6359
Age	26.4583	22.4407	24.3215
Indigenous	0.0428	0.0337	0.038
S. economic index			
Middle	0.5972	0.6099	0.6039
High	0.1102	0.1228	0.1169
Family background			
F. Problems	0.3053	0.3084	0.3069
Social cluster			
Religious	0.3246	0.3469	0.3364
Rock music	0.1643	0.2246	0.1963
Residence			
Urban	0.7034	0.7254	0.7151
Big City	0.3353	0.3664	0.3518
Center	0.161	0.1798	0.171
North East	0.2739	0.2325	0.252
North West	0.0381	0.0453	0.0419
Center West	0.3413	0.3506	0.3462
South, Sout Est	0.1857	0.1919	0.189

Table 3.3: OLS Regression for dropping after primary school N=3454

	Coefficient	t	Coefficient	t
Reform	-0.0702512	(-6.88)	-0.0673304	(-3.14)
Demographics				
Age	-	-	0.0006931	(0.15)
Female	0.0401523	(3.78)	0.0401702	(3.79)
Indigenous	0.116935	(4.12)	0.1168988	(4.11)
S. economic index				
Middle	-0.1476951	(-11.84)	-0.1477471	(-11.84)
High	-0.1844808	(-9.68)	-0.1845241	(-9.68)
Family background				
F. Problems	0.0239832	(2.17)	0.0239708	(0.98)
Social cluster				
Religious	0.001288	(0.12)	0.0012274	(0.11)
Rock music	-0.0476129	(-3.64)	-0.047542	(-3.63)
Residence				
Urban	-0.0342493	(-2.66)	-0.0341769	(-2.65)
Big City	-0.0401839	(-2.87)	-0.040146	(-2.87)
Center	-0.0107535	(-0.55)	-0.0107529	(-0.55)
North East	-0.0069529	(-0.41)	-0.0070345	(-0.42)
North West	-0.0189438	(-0.69)	-0.0188732	(-0.68)
Center West	0.0156049	(0.99)	0.0155663	(0.98)
Constant	0.272134	(13.59)	0.253659	-2.1

Table 3.4: Probability of having not sex during N=3454

	OLS	Probit	Mfx probit
Education			
Dropping after PS	-0.0288[0.0283]	-0.0733[0.0728]	-0.0292[0.0289]
Demographics			
Female	0.1619[0.0175]***	0.4163[0.0458]***	0.1639[0.0177]***
Indigenous	0.0926[0.0476]*	0.2384[0.1227]*	0.0947[0.0482]**
S. economic index			
Middle	0.0268[0.021]	0.0688[0.0545]	0.0274[0.0217]
High	0.0756[0.0316]**	0.1955[0.0822]**	0.0779[0.0326]**
Family background			
F. Problems	-0.0546[0.0182]***	-0.1422[0.0474]***	-0.0565[0.0188]***
Social cluster			
Religious	0.0419[0.0181]**	0.1079[0.0465]**	0.043[0.0185]**
Rock music	0.0181[0.0217]	0.048[0.0563]	0.0191[0.0225]
Residence			
Urban	-0.0643[0.0216]***	-0.1656[0.0555]***	-0.066[0.0221]***
Big City	-0.0073[0.0231]	-0.0199[0.0598]	-0.0079[0.0238]
Center	-0.0423[0.0323]	-0.1101[0.0839]	-0.0437[0.0332]
North East	-0.0154[0.0282]	-0.0385[0.0724]	-0.0153[0.0288]
North West	0.0128[0.0462]	0.0339[0.1186]	0.0135[0.0473]
Center West	0.0573[0.0262]**	0.149[0.0674]**	0.0594[0.0268]**
Constant	0.3909[0.0322]***	-0.2817[0.0836]***	

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3.5: Probability of having sex without condom (FSI) N=3454

	OLS	Probit	Mfx probit
Education			
Dropping after PS	0.0767[0.028]***	0.2049[0.0733]***	0.0761[0.028]***
Demographics			
Female	0.01[0.0166]	0.0288[0.0472]	0.0104[0.0169]
Indigenous	-0.0799[0.0445]*	-0.2245[0.1266]*	-0.0766[0.0406]*
S. economic index			
Middle	-0.0439[0.0207]**	-0.1222[0.0561]**	-0.0443[0.0204]**
High	-0.1302[0.0292]***	-0.3808[0.0876]***	-0.1266[0.0264]***
Family background			
F. Problems	0.0506[0.0177]***	0.1399[0.0485]***	0.051[0.0178]***
Social cluster			
Religious	-0.0229[0.0172]	-0.0632[0.0484]	-0.0226[0.0173]
Rock music	-0.0457[0.02]**	-0.1303[0.059]**	-0.046[0.0204]**
Residence			
Urban	0.0095[0.0206]	0.0254[0.057]	0.0091[0.0204]
Big City	-0.0046[0.0216]	-0.0149[0.0618]	-0.0054[0.0222]
Center	-0.0065[0.0313]	-0.0117[0.0863]	-0.0042[0.031]
North East	0.0373[0.0273]	0.1046[0.0737]	0.0381[0.0271]
North West	0.001[0.0433]	0.0003[0.1196]	0.0001[0.0431]
Center West	-0.0793[0.0253]***	-0.2256[0.07]***	-0.0798[0.0244]***
Constant	0.3741[0.0319]***	-0.321[0.0865]***	

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3.6: Probability of having sex without condom (FSI), conditional on having sex N=1797

	OLS	Probit	Mfx probit
Education			
Dropping after PS	0.108[0.0324]***	0.3638[0.1164]***	0.127[0.0373]***
Demographics			
Female	0.1927[0.023]***	0.531[0.0633]***	0.1981[0.0233]***
Indigenous	-0.064[0.0644]	-0.1991[0.1948]	-0.0764[0.0764]
S. economic index			
Middle	-0.05[0.0261]*	-0.1379[0.0773]*	-0.0511[0.0284]*
High	-0.1524[0.0429]***	-0.4068[0.118]***	-0.1577[0.0466]***
Family background			
F. Problems	0.0287[0.023]	0.0861[0.0669]	0.0319[0.0247]
Social cluster			
Religious	0.0123[0.0237]	0.0373[0.069]	0.0139[0.0256]
Rock music	-0.0572[0.0294]*	-0.1566[0.0784]**	-0.0593[0.0301]**
Residence			
Urban	-0.0744[0.0272]***	-0.232[0.084]***	-0.0844[0.0297]***
Big City	-0.0179[0.0306]	-0.0498[0.0852]	-0.0186[0.0319]
Center	-0.0675[0.0418]	-0.1863[0.1217]	-0.0707[0.0469]
North East	0.0296[0.0349]	0.0842[0.1077]	0.0311[0.0395]
North West	-0.0224[0.0588]	-0.0662[0.1738]	-0.0249[0.0661]
Center West	-0.0924[0.0338]***	-0.2593[0.1015]**	-0.098[0.0387]**
Constant	0.6589[0.0412]***	0.4511[0.124]***	

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3.7: OLS estimation for sexual behavior only women

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	-0.049[0.0328]	0.0764[0.0327]**	0.0812[0.0352]**
Demographics			
Indigenous	-0.064[0.0644]	-0.1991[0.1948]	-0.0764[0.0764]
S. economic index			
Middle	0.0539[0.0265]**	-0.0367[0.026]	-0.0074[0.0321]
High	0.1421[0.0418]***	-0.1275[0.0383]***	-0.0734[0.0612]
Family background			
F. Problems	-0.0588[0.0234]**	0.0565[0.0225]**	0.0293[0.0289]
Social cluster			
Religious	0.0389[0.0225]*	-0.0212[0.0215]	0.0152[0.0294]
Rock music	0.0265[0.0304]	-0.0432[0.028]	-0.0419[0.0435]
Residence			
Urban	-0.0725[0.0267]***	0.0228[0.0258]	-0.0761[0.0323]**
Big City	-0.0123[0.03]	-0.0448[0.028]	-0.1139[0.0413]***
Center	-0.0553[0.0413]	0.0518[0.0395]	0.03[0.0528]
North East	-0.0723[0.0353]**	0.0703[0.034]**	0.03[0.0425]
North West	-0.0791[0.0585]	0.0359[0.0558]	-0.0664[0.0738]
Center West	0.0521[0.0324]	-0.0384[0.0311]	-0.0054[0.0415]
Constant	0.5646[0.0372]***	0.3456[0.0359]***	0.8101[0.0469]***

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3.8: IV estimation for sexual behavior only women

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	-0.0811[0.2389]	0.2438[0.2285]	0.5099[0.4111]
Demographics			
Indigenous	0.0304[0.0646]	-0.045[0.0615]	-0.1178[0.1168]
S. economic index			
Middle	0.0487[0.0465]	-0.0096[0.0446]	0.0687[0.0817]
High	0.1353[0.065]**	-0.0922[0.0605]	0.0186[0.1089]
Family background			
F. Problems	-0.0578[0.0245]**	0.0513[0.0238]**	0.0142[0.0337]
Social cluster			
Religious	0.0393[0.0227]*	-0.0235[0.0217]	0.0093[0.0313]
Rock music	0.0244[0.0343]	-0.0319[0.032]	-0.0115[0.0531]
Residence			
Urban	-0.074[0.0289]**	0.0307[0.028]	-0.0607[0.0382]
Big City	-0.0135[0.0312]	-0.0385[0.0293]	-0.0963[0.0452]**
Center	-0.0568[0.0425]	0.0594[0.0411]	0.0485[0.0586]
North East	-0.0735[0.0363]**	0.0766[0.0353]**	0.0384[0.0461]
North West	-0.0814[0.0606]	0.0478[0.0573]	-0.0544[0.0755]
Center West	0.0517[0.0325]	-0.0361[0.0315]	-0.0027[0.0449]
Constant	0.5646[0.0372]***	0.3456[0.0359]***	0.8101[0.0469]***

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 3.9: IV estimation for sexual behavior men and women combined

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	-0.4567[0.2482]*	0.5259[0.2386]**	0.6847[0.3919]*
Demographics			
Female	0.1797[0.0204]***	-0.0087[0.0198]	0.1609[0.0322]***
Indigenous	0.1446[0.0562]**	-0.1345[0.0544]**	-0.1958[0.1164]*
S. economic index			
Middle	-0.0371[0.0429]	0.0233[0.0416]	0.0352[0.0647]
High	-0.0046[0.0561]	-0.046[0.0532]	-0.0503[0.082]
Family background			
F. Problems	-0.0443[0.0198]**	0.0398[0.0193]**	0.0107[0.0275]
Social cluster			
Religious	0.0412[0.0187]**	-0.0222[0.0179]	0.0136[0.0251]
Rock music	-0.0048[0.0256]	-0.0218[0.0241]	-0.0283[0.0363]
Residence			
Urban	-0.0789[0.0239]***	0.0248[0.0231]	-0.0575[0.0322]*
Big City	-0.0253[0.026]	0.0143[0.0245]	0.0057[0.0356]
Center	-0.0462[0.0335]	-0.0024[0.0328]	-0.0663[0.045]
North East	-0.016[0.0292]	0.0379[0.0287]	0.0247[0.0384]
North West	0.0045[0.0468]	0.0098[0.0438]	-0.0356[0.0625]
Center West	0.0646[0.0277]**	-0.087[0.0273]***	-0.1062[0.0383]***
Constant	0.4908[0.0661]***	0.2692[0.0644]***	0.5375[0.0962]***

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3.10: Bivariate probit estimation for sexual behavior men and women combined

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	-0.53[0.3742]	0.7408[0.3465]**	1.1984[0.3809]***
Demographics			
Female	0.4124[0.0461]***	0.028[0.0465]	0.509[0.0659]***
Indigenous	0.2344[0.1215]*	-0.2191[0.1249]*	-0.199[0.1843]
S. economic index			
Middle	0.0677[0.054]	-0.1198[0.0555]**	-0.1316[0.0744]*
High	0.1927[0.0815]**	-0.3754[0.0869]***	-0.3916[0.1149]***
Family background			
F. Problems	-0.1414[0.0469]***	0.1385[0.0479]***	0.0821[0.0643]
Social cluster			
Religious	0.1049[0.0462]**	-0.0604[0.0478]	0.0377[0.066]
Rock music	0.0449[0.0558]	-0.1258[0.0584]**	-0.1468[0.0762]*
Residence			
Urban	-0.1636[0.0549]***	0.0257[0.0562]	-0.2219[0.0817]***
Big City	-0.0207[0.0592]	-0.0147[0.061]	-0.0501[0.0819]
Center	-0.1075[0.0831]	-0.012[0.0851]	-0.1749[0.1189]
North East	-0.035[0.0717]	0.101[0.0726]	0.0793[0.103]
North West	0.0322[0.1174]	0.0037[0.1182]	-0.0567[0.1668]
Center West	0.148[0.0667]**	-0.2215[0.0695]***	-0.2431[0.1021]**
Constant	-0.2276[0.0955]**	-0.3786[0.0935]***	0.3354[0.1415]**

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3.11: IV estimation with cohort trend for sexual behavior men and women combined

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	-0.2403[0.4711]	0.4573[0.4633]	0.65145[0.3842]*
Demographics			
Female	0.1512[0.0261]***	-0.0058[0.0256]	0.1261[0.0509]**
Indigenous	0.0633[0.0745]	-0.1265[0.0699]*	-0.3318[0.2008]*
S. economic index			
Middle	0.0664[0.0728]	0.0131[0.0725]	0.1274[0.1179]
High	0.1244[0.0927]	-0.0587[0.091]	0.0588[0.1423]
Family background			
F. Problems	-0.0609[0.0217]***	0.0414[0.0213]*	-0.0087[0.0377]
Social cluster			
Religious	0.0414[0.0182]**	-0.0222[0.0177]	0.0148[0.0299]
Rock music	0.027[0.0312]	-0.0249[0.03]	-0.0011[0.0479]
Residence			
Urban	-0.0563[0.0268]**	0.0226[0.0263]	-0.0393[0.044]
Big City	0.0028[0.0301]	0.0116[0.0288]	0.0291[0.0462]
Center	-0.0395[0.0329]	-0.0031[0.0328]	-0.065[0.0534]
North East	-0.0098[0.0286]	0.0373[0.0287]	0.0237[0.0466]
North West	0.0156[0.0477]	0.0087[0.044]	-0.0511[0.0782]
Center West	0.0541[0.0275]**	-0.0859[0.0273]***	-0.1199[0.0496]**
Time trend	0.0229[0.0129]*	-0.0023[0.0125]	0.0175[0.0183]
Constant	0.2582[0.1484]	0.2921[0.147]	0.3538[0.2144]

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3.12: IV estimation (small cohorts) for sexual behavior men and women combined

	No sex	No condom[U]	No condom[C]
Education			
Dropping after PS	0.0538[0.3529]	0.4225[0.3447]	0.6447[0.369]*
Demographics			
Female	0.1506[0.0267]***	0.0207[0.0257]	0.195[0.0424]***
Indigenous	0.1455[0.0892]	-0.1357[0.0857]	-0.2864[0.2751]
S. economic index			
Middle	0.0747[0.058]	-0.0328[0.0577]	0.0729[0.1037]
High	0.0831[0.0804]	-0.0893[0.0771]	0.0088[0.1443]
Family background			
F. Problems	-0.0594[0.0268]**	0.0562[0.0269]**	0.0341[0.0424]
Social cluster			
Religious	0.0715[0.0275]***	-0.046[0.0265]*	0.0093[0.044]
Rock music	0.0016[0.0398]	0.0031[0.0376]	0.0525[0.0664]
Residence			
Urban	-0.0417[0.0333]	0.0215[0.0326]	-0.0036[0.0593]
Big City	-0.0017[0.0355]	-0.0028[0.033]	-0.0028[0.0541]
Center	-0.034[0.0495]	0.017[0.0495]	0.0053[0.0832]
North East	0.0319[0.0422]	0.0097[0.0421]	0.0472[0.0715]
North West	0.0521[0.0698]	-0.0042[0.0664]	0[0.117]
Center West	0.0678[0.0385]*	-0.1016[0.0395]**	-0.066[0.075]
Constant	0.3142[0.1034]***	0.319[0.1031]***	0.3329[0.2076]

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3.13: Probability of start smoking between 14 and 19 years old, OLS estimation

	Men and women	Women only
Education		
Dropping after PS	-0.0606[0.0206]***	-0.0705[0.0203]***
Demographics		
Female	-0.2219[0.0167]***	
Indigenous	-0.0412[0.0361]	-0.0791[0.0334]**
S. economic index		
Middle	0.0213[0.0182]	0.0091[0.0203]
High	0.0432[0.0294]	0.0189[0.0358]
Family background		
F. Problems	0.0644[0.0165]***	0.0585[0.0191]***
Social cluster		
Religious	-0.0431[0.0155]***	-0.044[0.0173]**
Rock music	0.0422[0.0209]**	0.0562[0.0272]**
Residence		
Urban	0.0822[0.0175]***	0.0852[0.0185]***
Big City	0.0714[0.0215]***	0.1064[0.0258]***
Center	0.1212[0.0289]***	0.0863[0.0341]**
North East	-0.0024[0.0236]	-0.0237[0.0263]
North West	-0.0342[0.039]	-0.0207[0.0447]
Center West	0.0191[0.0217]	-0.0142[0.0237]
Constant	0.3105[0.0277]***	0.1092[0.0261]***

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3.14: Probability of start smoking between 14 and 19 years old, IV estimation

	Men and women	Only women
Education		
Dropping after PS	-0.1051[0.213]	-0.3876[0.1948]**
Demographics		
Female	-0.2201[0.0189]***	
Indigenous	-0.0357[0.044]	-0.0454[0.0443]
S. economic index		
Middle	0.0147[0.0363]	-0.042[0.0379]
High	0.0349[0.0486]	-0.0477[0.0537]
Family background		
F. Problems	0.0656[0.0174]***	0.0689[0.0206]***
Social cluster		
Religious	-0.0433[0.0155]***	-0.0401[0.018]**
Rock music	0.0397[0.0238]*	0.0345[0.0301]
Residence		
Urban	0.0807[0.019]***	0.0706[0.0215]***
Big City	0.0695[0.0232]***	0.0946[0.0273]***
Center	0.1207[0.0289]***	0.0713[0.0363]*
North East	-0.0024[0.0236]	-0.0362[0.0281]
North West	-0.035[0.0389]	-0.0428[0.0478]
Center West	0.0198[0.0218]	-0.019[0.0248]
Constant	0.3209[0.0567]***	0.2092[0.0675]***

Standard errors in [] Significance level * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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List of Figures

List of Tables