An Analysis of Risk-Sharing Designs for the Colombian Health Insurance System*

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July 2, 2013

*__Very preliminary and for comments only__. Financial support from the Ministry of Health and Social Protection and the World Bank is greatly acknowledged. The usual disclaimer applies.

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Abstract

This study evaluates the efficiency and selection trade-off of four standard risk sharing mechanism that supplement standard prospective risk adjusted capitation payments in competitive insurance markets: Risk sharing of high risks, risk sharing of high costs, outlier risk sharing and proportional risk sharing. Using a unique data set with over 300 million health claims of more than 24 million Colombians' during year 2010, we estimate risk adjustment models with diagnostic related groups based on currently available information. We evaluate incentives for efficiency and risk selection by assuming that insurers are able to predict health costs based on this diagnostic related risk adjustment model while the government uses standard capitation formulas based on sex and age. We show that outlier risk sharing is never optimal. When insurers don't have valuable private information (diagnostic related model), risk sharing of high risks performs well. When the insurers do have private information, risk sharing for high costs performs better and marginally better than proportional risk sharing.

Keywords: Risk adjustment, Diagnostic Related Groups, Risk Selection.

JEL Codes: I11, I13, I18.

Contents

1 Introduction

Currently payments to the Colombian health insurance system consist of a prospective flat capitation payments that cover the basic mandatory health plan (*Plan Obligatorio de Salud - POS*), a retrospective proportional (usually total) risk sharing for selected high-cost services not covered by the basic health plan (e.g. none POS services), and an expost non neutral redistribution of resources among insurers based on the prevalence of renal chronic disease.[1] The literature suggests this is adequate because no matter how good is prospective risk adjustment, there always remains incentives for risk selection. Therefore whenever there is enough information it is recommended to improve the prospective risk adjustment formula and implement so sort of expost risk sharing or redistribution mechanism.

In Colombia, the richness of the information that insurers provide for the government provides an ideal laboratory for the introduction of state of the art exante risk adjustment and expost risk sharing mechanism. We address the problem of redesigning the prospective risk adjustment formula in a companion paper (Alfonso, Riascos, Romero (2013)) and focus in this paper on different alternative for implementing an expost risk sharing mechanism. In this article we will study four broad alternatives of risk, namely, Risk Sharing for High-Risks (RSHR), Risk Sharing for High-Costs (RSHC), Outlier Risk Sharing (ORS) and Proportional Risk Sharing (PRS); the analysis will be made under two scenarios: flat capitation payments and risk-adjusted capitation payments using demographic variables. The evaluation of the different mechanisms will be made upon by measuring the incentives for efficiency and selection that they give to the insurers. Our approach draws heavily on Van Barneveld (2000).

This paper is organized as follows. The second section makes a description of the selection and efficiency incentives that capitation payments and risk-sharing designs give to the insurers or EPSs (*Empresa Promotora de Salud*). The third section discuss the four risk-sharing mechanisms which will be evaluated in the present study. The fourth section will give a description of

[1]This redistribution is managed by the *Cuenta de Alto Costo*, a privately held institution of insurers but regulated by the Ministry of Health and Social Protection. Currently it makes redistributions related to renal chronic disease but soon they will start doing the same for HIV, Cancer, Arthritis and Epilepsy.

the performance measures that are going to be used for measuring efficiency and selection incentives. The sixth section will describe the methodology we will use for analysing the performance of each risk-sharing design. Results and conclusions will follow.

2 Efficiency and Selection

If a country seeks universal cover of health services, a competitive health-insurance market with no intervention from the government is not optimal. This is because the health conditions of some patients would make them pay exaggerated risk premiums to insurers. The problem is partly solved if the government collects a moderate contribution from each individual and makes a redistribution to pay the insurers for each patient. These payments are made at the beginning of the year and are called capitation payments.

Usually, governments have demographic information from patients, so they use it to predict health spending and make capitation payments accordingly. These predictors are far from perfect, and given the insurer's private information on the patients' health conditions, insurance companies may refuse to provide services to patients whose predicted costs are higher than the capitation payments the government is providing. This is called the selection problem.

Even when the law obliges companies to insure every individual who requests it, selection can be made through subtle mechanisms. Usually, insurers will give poor service to high-cost individuals so to deter them from demanding health services or to make them switch insurers. This is accomplished through heavy paper-work, long queues, long times waiting for medication and physician appointments, etc.

Two solutions are proposed to reduce incentives for selection. The first one is improving the calculation of capitation payments. This is accomplished increasing the efforts to record relevant health and demographic information from patients and through more efficient utilization of the available information. The literature suggests that improvements on capitation payments are possible, but usually not enough to sufficiently reduce selection incentives.

The second solution is a risk-sharing design. This consists of payments made by the government to the insurers at the end of the year to cover for losses the insurer might have had on extremely expensive patients. This design acts as reinsurance, so the insurance company should pay for this service to the government. Ideally, the mechanism should be budget-neutral, that is, the expected value of the amount the government will receive, minus the amount it will pay, should be zero.

Risk-sharing reduces incentives for selection. This is because when losses on high-cost individuals are shared between the insurer and the government, the insurer has fewer incentives to refuse or give poor services to high-cost patients. Nevertheless, risk-sharing reduces the incentives for efficiency in the provision of services.[2] Whenever there is a risk-sharing design, a reduction in costs will not have a direct impact on the insurer's profits, since a reduction in costs will bring a reduction in the reimbursement the government will pay as part of the risk-sharing program. This means a reduction in costs does not bring a direct increase in profits, which gives fewer incentives for efficiency. This is called the selection-efficiency tradeoff. Basically, it implies that whenever there is a risk-sharing mechanism, a reduction in selection incentives is accompanied by a reduction in efficiency incentives. In the next section, four different designs for risk sharing will be described.

3 Four Designs for Risk-Sharing

The risk-sharing methodologies that are going to be used in this study are completely specified by the values of four parameters. The first one is the percentage of patients that are going to participate from each EPS in the risk-sharing design, if this parameter is set to zero, there is no risk sharing at all, if it is set to one, all patients participate. The second parameter is a dummy variable which indicates whether patients that participate in the design are going to be chosen by the EPS at the beginning or the end of the year (ex-ante vs ex-post risk-sharing); this value will be set to one if patients are chosen at the beginning of the year. The third parameter is the

[2]We understand efficiency as the capacity to provide services of the same quality at lower prices or more services at the same prices.

value at which losses will start to be covered by the government; this value will be called the threshold value. If the threshold value, for example, is set at ten million pesos, the government will pay a fraction of the losses of the individuals that were chosen to participate in the design and whose losses exceed ten million pesos. The fourth parameter is the portion of the loss that the government is going to cover for the individuals that participate in the design and exceed the threshold.

For example assume the following values for a risk-sharing methodology.

$Percentage = 5\%$, $Ex-ante = 1$
$Threshold = 20.000.000$, $LossPortion = 80\%$.

This means that EPSs are going to choose 5% of their (expected most expensive) patients at the beginning of the year to be covered. If at the end of the year losses exceed 20.000.000 pesos for any of the patients chosen by the EPSs, the government will cover 80% of this loss.

Analysing the effects of every possible risk-sharing scheme would be a complicated task. In order to make the study simpler we will consider four different ways that a risk-sharing design can be implemented. Each of these will fix three of the four parameters and keep the other one free for calibration.

1. **Risk Sharing for High-Costs:** A percentage α fixed by the government will participate from each of the EPSs. The insurer chooses these patients at the end of the year. The government covers 100% of the losses from these patients. (The threshold T is set to zero)

2. **Risk Sharing for High-Risks:** A percentage α fixed by the government will participate from each of the EPSs. The insurer chooses these patients at the beginning of the year. The government covers 100% of the losses from these patients. (The threshold T is set to zero)

3. **Outlier Risk Sharing:** All patients will participate in the risk-sharing design. The government chooses a threshold value T. Whenever a patient's losses exceed the threshold value, the government will cover 100% of this value.

4. **Proportional Risk Sharing:** All patients will participate in the risk-sharing design. The government chooses a portion p at the beginning of the

year. At the end of the year, if a patient reports overall losses, the government will cover a fraction p of this value.

In this study, the risk-sharing mechanisms will only cover for patients that present losses. It is important to remember that a patient has losses whenever his or her costs exceed capitation payments. The loss is equal to the difference between costs and (adjusted) capitation.

4 Measuring Selection and Efficiency Incentives

In order to make an analysis of the tradeoff between selection and efficiency we need a measure of the incentives for selection and efficiency. The literature presents numerous indexes, an interesting review might be found in Van Barneveld (2000)

We will use the Mean Absolute Result (MAR) in order to measure incentives for selection. The Absolute Result for patient i is the absolute value of the difference between payments made to the EPSs by the government and the actual costs of the patient.

$$AR_i = |Payment_i - Cost_i| \tag{1}$$

It is easy to see that AR_i is a measure of the incentives for selection on patient i. If $Payment_i >> Cost_i$ the EPSs has incentives to attract patient i and if $Payment_i << Cost_i$ the EPSs have great incentives to get rid of the patient. Both conditions imply $AR_i >> 0$, therefore, the bigger AR_i, the greater the incentives for selection on i.

The Mean Absolute Result (MAR) is simply the average of the AR_i over all patients, that is

$$MAR = \sum_{i=1}^{N} |Payment_i - Cost_i| \tag{2}$$

The presentation of results will be more transparent if we choose an index which goes from zero to one. We choose the ratio between the MAR when there is risk-sharing and the MAR when there is no risk-sharing. In both cases there will be capitation payments. The selection index will be

$$Selection = \frac{\sum_{i=1}^{N} |CapPayment_i + RiskReimbursement_i - Cost_i|}{\sum_{i=1}^{N} |CapPayment_i - Cost_i|} \quad (3)$$

Here $CapPayment_i$ indicates the capitation payments made on individual i and $RiskReimbursement_i$ is the Risk Reimbursement the government pays the EPS as part of the risk-sharing design. A value of selection close to one means that risk-sharing does not improve on selection incentives in comparison with a capitation-payments-only design, a value close to zero means there is significant improvement.

For measuring incentives for efficiency we will be using the Insurer's Share of the Efficiency Gain (ISEG). As was indicated above, whenever there is a Risk-Sharing mechanism, a reduction of a patient's costs does not have a direct impact on the profits the EPSs receive from that patient. The ISEG is an overall measure of the percentage of the cost reduction that the insurer will receive as profits. ISEG is given by

$$ISEG = \frac{\Delta Profits}{\Delta Costs} \quad (4)$$

In order to calculate $ISEG$ we suppose Costs change by an amount $\Delta Costs$ and we observe the change in the overall profits. Since there is no historical data on cost changes when a Risk Sharing mechanism is in action, the cost changes will be simulated on the data we have at our disposal.

5 Methodology

An analysis of the four different risk-sharing methodologies will be made for two scenarios. Scenario 1 will consist of flat-capitation payments accompanied by risk-sharing. Scenario 2 will consist of risk-adjusted capitation payments accompanied by risk-sharing.

5.1 Capitation Payments

Flat payments are taken as the average of annualized costs (the section on data contains information on how this value is calculated) For calculating risk-adjusted capitation payments we use the information on age group and gender from each patient. We create groups of individuals for each combination of these two variables and assign as capitation payments the average of annualized costs within each group. This methodology is equivalent to adjusting a linear model by OLS where age group, gender and all possible interactions between these two variables are included. This design is similar to the one currently used by the Ministry of Health and Social Protectionof Colombia.

5.2 Profit and reimbursement calculation

For each scenario we calculate the profits the EPSs make on each of the patients at the end of the year before risk-sharing reimbursements. These profits are simply the capitation payments minus the cost of the services provided throughout the year. At the end of the year, a risk-sharing reimbursement will be given to the EPSs for each individual. The amount of this reimbursement depends on each patient's profits and the risk-sharing mechanism that is being used.

Risk-Sharing for High Costs (RSHC) reimbursement:

First we choose the percentage α of patients who will be covered by the design. Then we take a look at the portion α which presents the biggest losses in each of the EPSs. Whenever these losses are positive, the government reimburses the totality of the loss. This means the α quantile of the profit variable in each EPS will receive full reimbursement, whereas the rest of the population will have a reimbursement of zero.

Risk-Sharing for High Risks (RSHR) reimbursement:

Simulating reimbursements for this design presents certain difficulties. This is because we do not know how EPSs are going to choose patients to be covered by the design at the beginning of the year. In RSHC this is not a problem, since the EPSs know actual costs when they are about to choose the population which will be covered; this means the EPSs simply choose the individuals with the largest losses.

We assume the EPSs make a prediction of the profits of each patient at the beginning of the year and they choose the individuals with the largest predicted losses. The EPSs will fit a linear model to predict costs. The predictor variables are going to be: age group, gender and dummy variables for 32 different chronic diseases (the dummy variable is equal to one whenever the individual). Such model will be fitted using LAD (Least Absolute Deviation).

Three remarks are important. First, we do not use the same information to make predictions as we do for adjusting the LAD model, as this is contrary to what would happen in a real scenario (where costs at the end of the year are unknown and cannot be used to fit any model). Instead, we randomly divide the database in two parts and use the first to predict the second and vice versa.

Second, a LAD model was chosen because the insurers' incentives for selection are aligned toward linear losses. There is no reason to think that insurers consider square errors in predictions, making LAD more adequate than OLS. Van Barneveld (2000) discusses this issue.

Third, we included chronic diseases in the model used by EPSs. This is because we assume that EPSs have private information on the patients' health status which gives them an advantage over the government in predicting patients' annual costs.

After fitting the LAD model, the EPSs choose the α portion with the highest predicted losses. If any of the individuals who were chosen reports positive losses at the end of the year, the full value of the loss is reimbursed to the EPS. The rest of the population receives a reimbursement of zero.

Outlier Risk-Sharing (ORS) reimbursement:

A threshold T is chosen. All patients whose losses exceed the threshold value will receive a full reimbursement of the losses. The rest of the population receives a reimbursement of zero.

Proportional Risk-Sharing (PRS) reimbursement:

A portion p is chosen. For all individuals that report positive losses, a fraction p of such losses will be reimbursed. The rest of the population will receive a reimbursement of zero.

5.3 Selection and efficiency indexes

Each of the four risk-sharing methodologies has a free parameter to be set by the government. We choose values for these parameters and calculate reimbursements for each design. Calculations on the selection index are made according to (3). After this, a simulation of a drop in costs by 10% is made and new profit values are calculated. With this information, the efficiency index is obtained using (4).

We obtain, for each risk-sharing methodology, the selection and efficiency indexes. This analysis is done up to 30 times, varying the parameter in each of the four risk-sharing schemes. Thus, we obtain 30 points in efficiency vs. selection space for each methodology.

5.4 Budget-Neutrality

We seek a budget-neutral risk sharing mechanism. This means the government has to charge the EPSs in order to cover the cost of reimbursements. To accomodate this, we calculate the totality of capitation payments and reimbursements, and subtract the amount the government receives from patients. This gives the government's deficit. This deficit is divided amongst the EPSs using shares proportional to the number of patients. the result is the amount each EPS has to pay the government for the risk-sharing services.

6 Results

Figures 1 and 2 present the tradeoff between efficiency and selection for the two different scenarios. Instead of graphing the selection index we graph a non-selection index defined as

$$NonSelection = 1 - Selection \tag{5}$$

The more to the rightward and upward direction a curve is situated, the better tradeoff between selection and efficiency it provides. The point at the upper-left corner corresponds to the absence of risk-sharing mechanisms. In this case the efficiency incentives are maximal since reduction in costs has a direct impact on profits, whereas incentives for non-selection are minimal because the absence of risk-sharing makes for selection of profitable patients the optimal choice. The point at the lower-right corner corresponds to full cover of losses. In this case there are no incentives for selection, since all losses are covered by the government, but there are no incentives for efficiency either, since a reduction of costs generates a reduction in profits by the same amount.

Figure 1, which corresponds to risk sharing with flat capitation payments, shows a similar tradeoff among RSHC, RSHR and PRS. Outlier Risk Sharing presents a poor behavior in comparison with the other three methodologies. A similar result is found by Van Barneveld (2000). Although not by much, Risk Sharing for High Costs is superior to the other methodologies whenever the non-selection index is above 0.2.

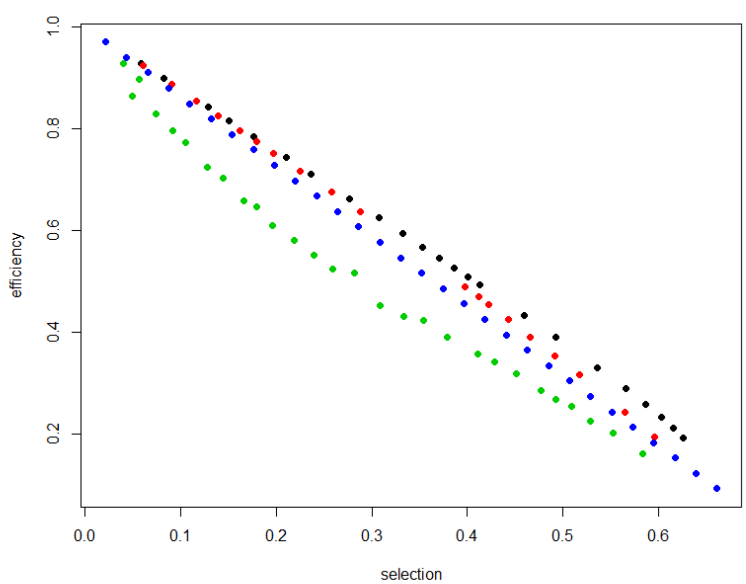

Figure 1: Risk Selection and Efficiency Tradeoff: Flat Capitation Payment. Black is RSHC, Red is RSHR, Blue is Proportional Risk Sharing and Green is outlier risk sharing.

Figure 2, which corresponds to risk sharing with risk-adjusted capitation payments, shows that Risk-Sharing for High Costs is superior to the other methodologies for non-selection indexes above 0.15. Outlier Risk Sharing shows again a poor behavior.

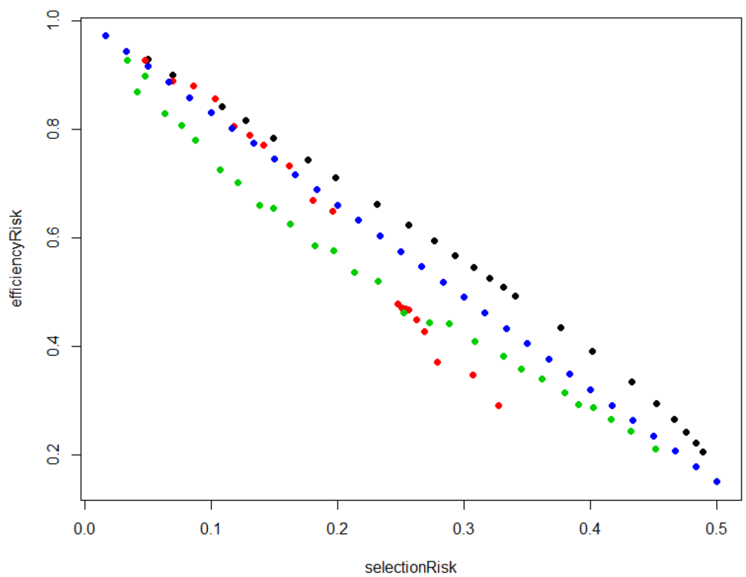

Figure 2: Risk Selection and Efficiency Tradeoff: Standard Demographic Risk Adjustment. Black is RSHC, Red is RSHR, Blue is Proportional Risk Sharing and Green is outlier risk sharing.

A comparison between Figure 1 and Figure 2 shows a similar behavior in RSHC, ORS and PRS. The performance of Risk-Sharing for High Risks drops dramatically after the non-selection index reaches a value of 0.25 in Figure 2. There are at least two explanations for this situation. First, in scenario 1, the capitation payments for a patient do not reduce selection incentives, since payments are made independent of the patient's risk variables. This means that the model used by EPSs to select patients to be insured in the RSHR mechanism gives a huge improvement on selection indexes. In scenario 2, capitation payments already have a component of risk-adjustment, so the improvement on the non-selection index accomplished by the EPSs model is not that impressive. Second, in order to accomplish a high non-selection index with RSHR, the percentage of patients which must be chosen to participate in the design must be big (and this is because the EPSs model is not a perfect predictor). When the percentage of such patients is so big, the probability that their losses are not going to be positive is high. Thus, only a small fraction of insured patients will receive reimbursement, making the RSHR design not that effective for high non-selection indexes.

7 Conclusions

Proportional Risk Sharing and Risk Sharing for High Costs have a good performance on the selection-efficiency tradeoff. RSHC is superior in both scenarios by a small margin, especially when the selection incentives want to be reduced as much as possible. Outlier Risk Sharing presents a poor performance. This is because the design does not provide incentives for efficiency; if a patient, for example, has already exceeded the threshold T, there are no incentives for costs reduction, since the government will pay the totality of the costs; on the other hand, if a patient has not exceeded T yet, the EPSs might not want to reduce costs expecting that at the end of the year, the patient will have exceeded T and losses will be completely covered.

The performance of Risk Sharing for High-Risks depends on capitation payments. If these are not correctly adjusted, RSHR has a good performance. This is because with RSHR, the private information of the EPSs is used to correct selection incentives. On the contrary, if capitation payments have been risk-adjusted, then RSHR does not behave well, especially if the risk-sharing design wishes to reduce selection incentives considerably.

This study gives two recommendations. First, the information on health and demographic variables should be used to make adequate capitation payments. Currently, only age, gender and location are used to fit the capitation payments model. This provides a poor fit which can be considerably improved with the use of health variables such as chronic diseases. Second, the optimal risk-sharing mechanism to be used is Risk Sharing for High-Costs, although Proportional Risk Sharing presents good results as well. RSHR should be considered if there is not enough information to make a good fit of capitation payments and if it is believed that EPSs have high-quality private information for the prediction of patients' costs. Outlier Risk Sharing should be avoided, since it does not provide good incentives for efficiency.

References

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8 Apendix: Chronic Diseases

Below, the chronic-disease groups used based on classification CIE10:

Genetic and congenital abnormalities, arthritis, pyogenic arthritis and reactive arthritis, asthma, autoimmune disease, cancer insitu cervix, invasive cervical cancer, male genital cancer, breast cancer, cancer and skin melanoma, cancer digestive organs, respiratory system cancer, other cancer, other female genital cancer, lymphatic cancer and related tissue therapy, cancer, diabetes, cardiovascular disease - hypertension, cardiovascular disease, other long lasting lung disease, kidney - chronic renal failure, renal failure - kidney failure other, kidney - other renal, kidney long lasting, AIDS-HIV, seizure syndromes (epilepsy), transplants, tuberculosis.