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A Note on Risk-Sharing Mechanisms for the Colombian Health Insurance System*

Álvaro J. Riascos† Sergio A. Camelo‡

Abstract

We evaluate, in terms of efficiency and selection incentives, four different ex post risk sharing mechanisms. Outlier risk sharing (ORS), proportional risk sharing (PRS), risk sharing for high costs (RSHC) and risk sharing for high risks. Our results suggest that the best mechanism in terms of their implied efficiency selection trade off are, risk sharing for high costs and risk sharing for high risks. In general, outlier risk sharing has a poor performance. Our results are robust with respect to different scenarios for ex ante risk adjustment or incentives for efficiency and selection based on expected or realized costs. We believe that the most realistic scenario analysed is one in which insurance companies use expected reimbursements and costs as their best source of information (signal) to decide on efficiency and selection trade-offs. In this case, we found that risk sharing of high risks dominates all other mechanisms.

JEL Classification: I11, I13, I18, C45, C55

Keywords: risk adjustment; risk selection; efficiency.

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Una Nota sobre Mecanismos de Riesgo Compartido en el Sistema de Aseguramiento de Salud en Colombia*

Álvaro J. Riascos† Sergio A. Camelo‡

Resumen

En este trabajo evaluamos, en términos de eficiencia y selección de riesgos, cuatro mecanismos de ajuste de riesgo compartido. Riesgo compartido de costos atípicos, riesgo compartido proporcional, riesgos compartidos de costos altos y riesgos compartidos de riesgos altos. Nuestros resultados sugieren que los mejores mecanismos en términos de los incentivos que generan a la eficiencia y selección de riesgos, son los mecanisos de riesgos compartidos de costos altos y riesgos compartidos de riesgos altos. En general, el mecanismo de riesgos compartidos de costos atípicos tiene el peor desempeño. Nuestros resultados son robustos a diferentes formas de pago ex ante o, incentivos estimados utilizando los costos y beneficios esperados de las aseguradoras. El caso más realista que consideramos es uno en el que las aseguradoras basan sus acciones en los reembolsos y costos esperados como su mejor fuente de información para ponderar sus incentivos a la eficiencia y seleción. En este caso encontramos que el mecanismo de riesgo compartidos de los más riesgosos domina a todos lo demás mecanismos.

Código JEL: I11, I13, I18, C45, C55

Palabras clave: ajuste de riesgo; selección de riesgos; eficiencia.

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1 Introduction

Currently, payments to the Colombian health insurance system consist of ex ante risk adjusted capitation payments based on age, sex and localization and an expost risk sharing mechanism for selected long duration diseases (e.g., renal chronic disease). The literature suggests this is adequate when data about socioeconomic and health factors of the patients is scarce, but whenever information makes it possible to improve on the capitation formula and implement new risk sharing mechanisms, the insurer's incentives for inefficiency and selection might be considerably reduced.

In Colombia, the richness of the information that insurers provide to the government makes a new design of payments in the health insurance system feasible. In this note we provide an analysis of four alternatives to the current health insurance system, 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 comparison of the different methodologies will be made upon the incentives for efficiency and selection that they give to the insurers.

The second section of this note makes a description of the selection and efficiency incentives that capitation payments and risk-sharing designs give to the insurers. The third section discusses the four risk-sharing methodologies which will be evaluated in the present study. The fourth section gives a description of the indexes that are going to be used for measuring efficiency and selection incentives. The fifth section will describe the methodology we will use for analysing the performance of each risk-sharing design. The sixth section presents the results and the last section presents the conclusions.

2 Efficiency and selection

If a country seeks universal coverage 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 insured agent. These payments are made at the beginning of the year and are called capitation payments.

Usually, governments have demographic information from insured agents, 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 individuals health conditions, insurance companies may refuse or

discourage to insure people whose predicted costs are higher than the capitation payments the government is paying. This is called the selection problem.

Even when the law obliges insurers 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 to an other insurer. This is accomplished through heavy paper-work, long queues, long waiting times 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, baiting times 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 mechanism. This consists of payments made by the government to the insurers at the end of the year to cover for losses the insurers might have had on extremely expensive patients. This mechanism acts as reinsurance, so insurance company's 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. Whenever there is a risk-sharing mechanism, 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 mechanism for risk sharing will be described. and we introduce indexes

for measuring selection and efficiency incentives. Afterwards, an analysis of the selection-efficiency tradeoff will be made for the four different risk-sharing mechanisms.

3 Four mechanisms 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 the people insured that are going to participate from each insurer in the risk-sharing mechanism, if this parameter is set to zero, there is no risk sharing at all, if it is set to one, everyone participates. The second parameter is a dummy variable which indicates whether insured agents that participate in the mechanism are going to be chosen by the insurer 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 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 to ten million Colombian 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 proportion of the loss that the government is going to cover for the individuals that participate in the mechanism and exceed the threshold.

For example, suppose we have the following values for a risk-sharing mechanism: Percentage=5%, Ex-ante dummy=1, Threshold = 20.000.000 and LossPortion=80%.

This means that the insurer is going to choose 5% of its enrollees at the beginning of the year to be covered. If at the end of the year losses exceed 20.000.000 Colombian pesos for any of the individual chosen by the insurer, the government will cover 80% of this loss.

Analysing the effects of every possible risk-sharing mechanism would be a very complicated task. In order to make the study simpler but enlightening at the same time 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 insurers. The insurer chooses α of the insured agents 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 of the insured agents, fixed by the government, will participate from each of the insurers. The insurer chooses these agents at the beginning of the year.

The government covers 100% of the losses from these agents. (The threshold T is set to zero)

3. **Outlier Risk Sharing:** All individuals will participate in the risk-sharing mechanism. The government chooses a threshold value T. Whenever an insured agent losses exceed the threshold value, the government will cover 100% of this value.

4. **Proportional Risk Sharing:** All insured will participate in the risk-sharing mechanism. The government chooses a portion p at the beginning of the year. At the end of the year, if an insured agent 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.

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 (2001).

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

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

It is easy to see that AR_i is a measure of the incentives for selection on agent i. If $Payment_i >> Cost_i$ the insurer has incentives to attract agent i and if $Payment_i << Cost_i$ the insurer has greater incentives to get rid of the agent. 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 insured agents, 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:

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

Here $CapPayment_i$ indicates the capitation payments made on individual i and $RiskReimbursement_i$ is the risk reimbursement the government pays the insurer as part of the risk-sharing mechanism. A value of selection close to one means that risk-sharing does not improve on selection incentives in comparison with a capitation-payments-only mechanism, 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 an insured agent 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

$$ISEG = \frac{\Delta Profits}{\Delta Costs} \tag{4}$$

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 with 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.

Our data set consists of the 2010, Base de Suficiencia of the Minsitry of Health and Social Protection.

5.1 Capitation payments

Flat payments are taken as the average of annualized costs. For calculating risk-adjusted capitation payments we use the information on age group and gender from each agent. 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 where age group, gender and all

possible interactions between these two variables are included. This mechanism is similar to the one currently used by the Health Ministry (Ministerio de Salud).

5.2 Profit and reimbursement calculation

For each scenario we calculate the profits the insurer makes on each of the insured agents 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 insurers for each individual. The amount of this reimbursement depends on each agent'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 insured agents who will be covered by the mechanism. Then we take a look at the portion α which presents the biggest losses in each of the insurers. Whenever these losses are positive, the government reimburses the totality of the loss. This means the α quantile of the profit variable in each insurer 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 insurers are going to choose enrollees to be covered by the mechanism at the beginning of the year. In RSHC this is not a problem, since the insurers know actual costs when they are about to choose the population which will be covered; this means the insurer simply chooses the individuals with the largest losses.

We suppose the insurers make a prediction of the profits of each agent at the beginning of the year and they choose the individuals with the largest predicted losses. The insurer 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 (for further details see `http://www.alvaroriascos.com/research/healtheconomics/`). 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 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 long duration diseases in the estimation of the model used by insurers. This is because we suppose the insurers have private information on the agents' health status which gives them an advantage over the government in predicting agents' annual costs.

After fitting the LAD model, the insurer 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 insurer. The rest of the population receives a reimbursement of zero.

Outlier Risk-Sharing (ORS) reimbursement:

A threshold T is chosen. All agents 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 mechanism. Calculations on the selection index are made according to (3). After this, a simulation of a reduction 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 insurers in order to cover the cost of reimbursements. To accommodate this, we calculate the totality of capitation payments and reimbursements, and subtract the amount the government receives from agents. This gives the government's deficit. This deficit is divided amongst the EPSs using shares proportional to the number of insured agents. The result is the amount each insurer has to pay the government for the risk-sharing services.

6 Results

In figure 1 and figure 2 we present the trade-off 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.

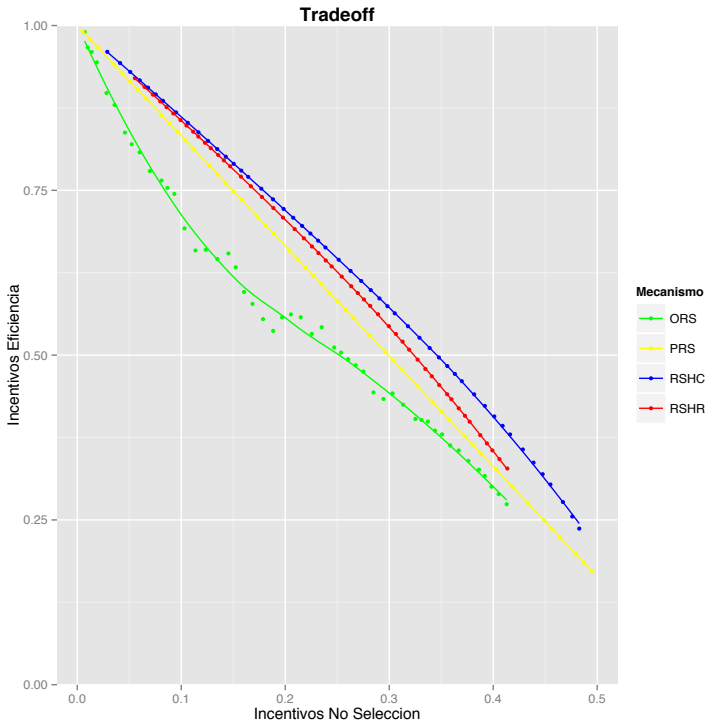

Figure 1: Tradeoff Efficiency incentives vis no selection incentives: flat payment

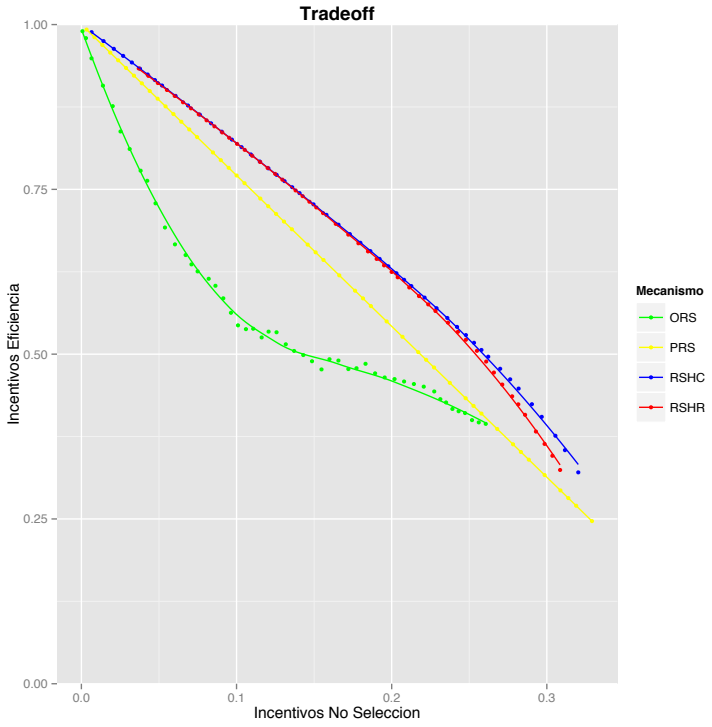

Figure 2: Tradeoff Efficiency incentives vis no selection incentives: risk adjusted payment

The more to the rightward and upward direction a curve is situated, the better trade-off 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 agents 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 (2001). 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 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.

The previous results of the risk-sharing mechanisms are done under the assumption that "actual" costs and payments are adequate when calculating incentives for selection and efficiency. This is an accurate description if selection and efficiency incentives are configured at the end of the year using information from the previous year. In this case, since we are using actual costs for 2010, the information would be available for insurers at the end of the year so they can configure their selection and efficiency incentives for operating during 2011.

Another approach to the problem, which might be more in line with behaviour of insurance companies, is that instead of using realized costs and payments from the year before, insurers configure their incentives according to "expected" costs and payments for the upcoming year. In this section we explore two methodologies for working with expected costs and payments. It will be shown that the results from the previous section are robust under these new assumptions.

6.1 Expected costs and payments

In this section we suppose that formulas for the calculation of selection and efficiency incentives hold, but instead of using actual costs and payments, we use expected costs and expected payments. This assumption might be more in line with reality, since insurers do not select based on realized costs, but based on the costs they expect. This adjustment leaves the incentives' formulas as

$$Selection = \frac{\sum_{i=1}^{N} |CapPayment_i + E(RiskReimbursement_i) - E(Cost_i)|}{\sum_{i=1}^{N} |CapPayment_i - E(Cost_i)|} \tag{5}$$

$$ISEG = \frac{\Delta E(Profits)}{\Delta E(Costs)} \tag{6}$$

Expectations are calculated according to the insurers beliefs about the future. This presents no difficulty since we assumed that the insurers fit a LAD model to predict the patients costs. Thus, we take these predicted costs as the expected costs required in the previous equations. Expected profits and expected risk reimbursements are calculated taking expected costs instead of actual costs.

We calculate the selection-efficiency tradeoff under these new assumptions. The results are shown in figure 3.

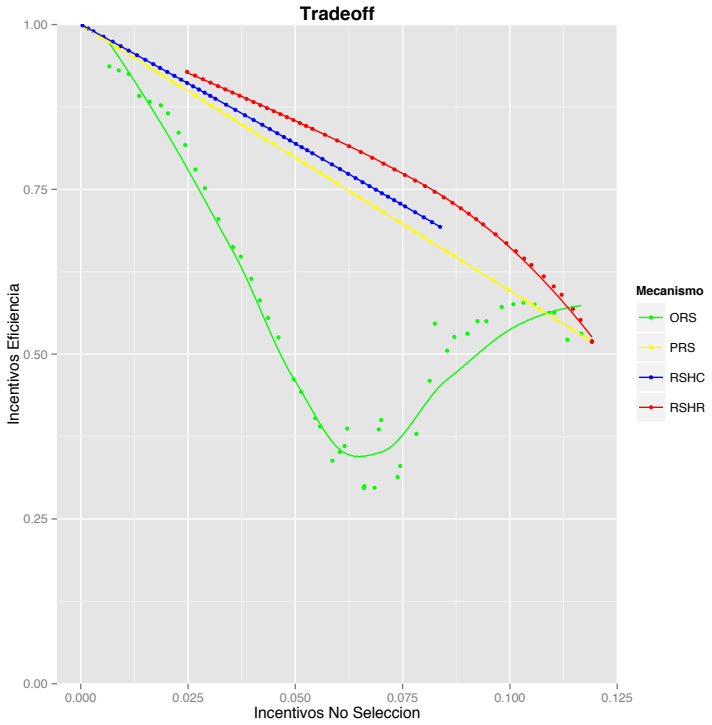

Figure 3: Tradeoff Efficiency incentives vis no selection incentives: Expected costs and payments

The behavior is similar to the one observed when actual costs are used. In this case, however, RSHR dominates RSHC. This was to be expected, since the selection incentives are now calculated using expected costs, and RSHR chooses exactly those agents for which expected costs are the highest. Intuitively, RSHR covers the risk against those agents that insurance companies believe could cost a lot of money, therefore, after the mechanism is implemented the insurers have no more incentives to refuse services.

6.2 Risk averse insurer

The previous methodology takes into account expected costs instead of actual costs. It might be argued, however, that this approach obviates the implicit risk in the costs that an individual could generate. By this we mean that selection is not always done on the basis of expected costs, but also on its volatility. It is perfectly possible that even when the government covers the expected costs of a patient, the insurer will refuse services for fear of high volatility in the generation of costs (which is in line with a risk-adverse insurer).

In order to work with this difficulty we propose the following calculation of the selection and efficiency incentives.

$$Selection = E\left[\frac{\sum_{i=1}^{N} |CapPayment_i + RiskReimbursement_i - Cost_i|}{\sum_{i=1}^{N} |CapPayment_i - Cost_i|}\right] \tag{7}$$

$$ISEG = E\left[\frac{\Delta Profits}{\Delta Costs}\right] \tag{8}$$

The expected value is taken over the beliefs that the insurers have on the distribution of costs for patients. When the expected value is taken outside of the absolute value, the volatility fraction of costs and payments is incorporated into the measurement of the incentives (contrary to the previous approach, where expected values where taken inside of the absolute values and fractions).

The calculation of this expected values depends on the distribution of costs only (since risk payments and profits depend on costs). In this study we calculate the expected values parametrically assuming normality in the distribution of costs.

For each insured agent, the mean of costs is assumed to be the costs predicted by the insurer, and the volatility of costs is estimated fitting a linear model by OLS: regressing the squared error in the prediction against the socio-economic and health covariates. The mean and variance determine uniquely the distribution of the costs when normality is assumed.

Finally, the expected value in equations (7) an (8) is calculated using a Monte Carlo technique. We simulate costs for each patient using their mean and variance and we calculate the selection and efficiency incentives. This process is repeated 10 times and results are averaged. Because the database is so big, there is little variance in the simulations' results, so only 10 implementations are necessary to ensure an accurate calculation of the expected values in (7) and (8).

Figure 4 shows the results for the four mechanisms' tradeoff.

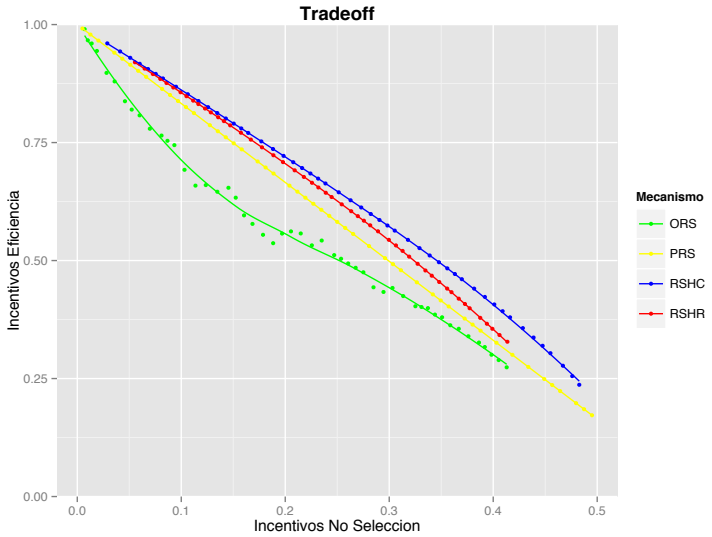

Figure 4: Tradeoff Efficiency incentives vis no selection incentives:

Again, RSHC and RSHR are the best mechanisms while ORS performs poorly. Contrary to the previous implementation, RSHR does not dominate (except for a small portion of the curve). This is because one of the biggest advantages of RSHC is that it reduces the variance on the insurers losses, and this was not captured when volatility was not taken into account.

7 Conclusions

We have evaluated, in terms of efficiency and selection incentives, four different ex post risk sharing mechanisms. Outlier risk sharing (ORS), proportional risk sharing (PRS), risk sharing of high costs (RSHC) and risk sharing for high risks (see section 3 for a detailed description of these mechanisms). Our results suggest that the best mechanism in terms of their implied efficiency selection trade off are risk Sharing for High Costs and risk sharing for high risks In general, outlier risk sharing has 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 an agent has not exceeded T yet, the insurer might not want to reduce costs expecting that at the end of the year, the agent will have exceeded T and losses will be completely covered.

We provided several robustness checks for our results based on different scenarios for ex ante risk adjustment or incentives for efficiency and selection based on expected or realized costs. We believe that the most realistic scenario analysed is one in which insurance companies use expected reimbursements and costs as

their best source of information (signal) to decide on efficiency and selection trade-offs (see section 6.1 for further details). In this case we found that risk sharing for high risks dominates all other mechanisms.

Our main conclusions based on the exercises in this note are: (1) 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. This would reduce the information asymmetry between the government and insurers and (2) The best risk sharing mechanism to be used is Risk Sharing for High Risks. (3) Outlier Risk Sharing should be avoided, since it does not provide good incentives for efficiency.

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