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RISK CORRIDORS AND REINSURANCE IN HEALTH INSURANCE MARKETPLACES: INSURANCE FOR INSURERS

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ABSTRACT

In order to encourage entry and lower prices, most regulated markets for health insurance include policies that seek to reduce the uncertainty faced by insurers. In addition to risk adjustment of premiums paid to plans, the Health Insurance Marketplaces established by the Affordable Care Act implement reinsurance and risk corridors. Reinsurance limits insurer costs associated with specific individuals, while risk corridors protect against aggregate losses. Both tighten the insurer's distribution of expected costs. This paper considers the economic costs and consequences of reinsurance and risk corridors. Drawing a parallel to individual insurance principles first described by Arrow (1963) and Zeckhauser (1970), we first discuss the optimal insurance policy for insurers. Then, we simulate the insurer's cost distribution under reinsurance and risk corridors using health care utilization data for a group of individuals likely to enroll in Marketplace plans from the Medical Expenditure Panel Survey. We compare reinsurance and risk corridors in terms of insurer risk reduction and incentives for cost containment, finding that one-sided risk corridors achieve more risk reduction for a given level of cost containment incentives than both reinsurance and two-sided risk corridors. We also find that the ACA policies being implemented in the Marketplaces (a mix of reinsurance and two-sided risk corridor policies) substantially limit insurer risk but that they are outperformed by a simpler one-sided risk corridor policy according to our measures of insurer risk and incentives.

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Section 1: Introduction

It is well known that health insurance markets are subject to a variety of distortions and market failures that threaten efficiency. The most commonly cited problems are adverse selection and moral hazard. However, an additional factor, the level of risk borne by insurers (i.e. the probability of randomly getting a high cost draw of enrollees) can also limit efficiency. Under high levels of uncertainty, risk-averse insurers will charge higher premiums, potentially exacerbating inefficiencies from adverse selection (Einav and Finkelstein 2011). Risk-averse insurers may also be less likely to enter high-risk markets, worsening inefficiencies from imperfect competition. It may, therefore, be socially beneficial to limit insurer risk by implementing reinsurance and risk corridors. While these policies protect insurers from uncertainty, they also weaken insurer incentives to restrain enrollee spending, a trade-off parallel to the trade-off between risk protection and moral hazard described in Zeckhauser (1970) for individual health insurance. Despite widespread use of these policies to limit insurer risk in the new health insurance Marketplaces created under the Patient Protection and Affordable Care Act (ACA), Medicare Part D, and many state Medicaid Managed Care markets, there is surprisingly little research on the implications of this trade-off for insurance markets.

Four primary tools protect health plans against the financial risk associated with adverse selection: pricing of health plan premiums, risk adjustment, reinsurance, and risk corridors. All four of these tools are being used in the Health Insurance Marketplaces, and each ameliorates selection problems differently. Pricing of health plan premiums can be adjusted for enrollee age or health status so as to match plan revenues for an individual more closely to expected costs. Risk adjustment redistributes revenues from plans with healthier than average enrollees to plans with sicker than average enrollees. Reinsurance pools the costs of the sickest enrollees across plans. Risk corridors redistribute revenues from plans earning large profits to plans incurring large losses.[1] While there has been a great deal of research on the effects of risk adjustment and pricing of health plan premiums on insurer and consumer behavior (see McGuire et al. 2013, Glazer et al. 2013, Handel et al. 2013, Shi 2013, Layton 2014, Mahoney and Wehl 2014), the effects of reinsurance and risk

[1] One could add the individual mandate to this list, a requirement designed to ensure both low and high-risk individuals participate in the risk pool.

corridors have largely been overlooked. Fundamentally, reinsurance and risk corridors act as insurance for insurers as they aim to protect insurers from the potential losses that could occur if they enroll an *unexpectedly* unhealthy group of enrollees. This is different from risk adjustment and premium-rating which protect plans against non-random, predictable variation in enrollee costs across plans. In this paper, we study the effects of these policies designed to limit the uncertainty faced by insurers on insurer risk and incentives. We start by developing a framework for evaluating the performance of alternative risk-reducing policies according to their effect on insurer risk and insurer incentives to restrain enrollee spending. The motivation for limiting insurer risk comes from an assumption that insurer behavior reflects the risk-aversion of the managers making decisions at the firm.[2] This leads to higher prices and limited competition in the presence of uncertainty. However, while it may be socially desirable to limit insurer risk, doing so may conflict with the goal of encouraging insurers to limit their enrollees' consumption of medical services.[3] Similar to individual health insurance policies, policies that protect insurers from risk often reduce the insurer's marginal price of an extra dollar of an enrollee's medical spending, weakening insurer incentives to limit their enrollees' utilization of medical services.

Our framework thus draws an analogy between protecting insurers from uncertainty and the problem of protecting individuals from uncertainty as studied by Arrow (1963) and Zeckhauser (1970), suggesting that the design of the optimal insurer risk-reducing policy would mimic the optimal individual health insurance contract. Briefly, if insurer risk-aversion mimics individual risk-aversion in that it is based on diminishing marginal utility of profits, then in the absence of moral hazard, but with some transaction costs of insurance, a policy that reimburses insurers for all costs beyond a certain loss threshold (i.e. full coverage after a deductible) is optimal. If there is some moral hazard (i.e. insurer behavior changes in the presence of the risk-reducing policy), partial coverage after a deductible will be optimal. The implication of these results is that in the absence of moral hazard, risk corridors, which mimic the "full coverage after a deductible" policy, are preferred to reinsurance. This is because risk corridor payments apply only when a plan's total costs fall in

[2] We provide justification for this assumption in Section 3.1.
[3] Due to the fact that when a consumer's marginal price for medical services is reduced by insurance, insured consumers "over-consume" services. This behavior is known asmoral hazard, and it is socially desirable for insurers to limit this it.

the extreme tails of the insurer's cost distribution, whereas reinsurance results in payments to plans when their total costs fall in all parts of the cost distribution. Because risk is reduced most efficiently by eliminating the tails of the distribution, risk corridors are likely to reduce insurer risk more efficiently than reinsurance. This principle has previously been applied to hospital outlier payments in the Medicare Prospective Payment System in the United States (Ellis and McGuire 1988, Keeler et al. 1988).

We use our framework to compare empirically the relative performance of reinsurance and risk corridors. We operationalize insurer risk using measures commonly used in economics and finance. We operationalize insurer incentives to restrain spending using the concept of the "power" of a payment system as applied by Geruso and McGuire (2014). Power is defined as the portion of the marginal dollar, on average, of the medical spending of an insurer's enrollees borne by the insurer. Thus, if a contract is high-powered insurers have a strong incentive to constrain utilization and if a contract is low-powered that incentive is weak. Risk-reducing policies in general, and reinsurance and risk corridors in particular, affect the power of the contract between the regulator and the insurer by reducing the insurer's marginal price of an enrollee's healthcare utilization.

In order to quantify the trade-off between risk-reduction and insurer incentives, we simulate the distribution of potential costs faced by an insurer by taking a large number of draws from a sample of Marketplace-eligible individuals constructed from the Medical Expenditure Panel Survey (MEPS). Each draw represents a potential state of the world faced by the insurer. Using the simulated cost distribution we determine the effect of reinsurance and risk corridors on insurer risk by applying these policies and then calculating our risk measures. We then follow Geruso and McGuire (2014) and construct an empirical measure of power under each policy via simulation. We do this for a variety of reinsurance and risk corridor policies offering insurers a wide range of levels of risk protection.

We compare reinsurance and two types of risk corridors, one where plans that enroll an unexpectedly high-cost group get positive transfers and plans that enroll an unexpectedly low-cost group are assessed penalties (two-sided risk corridors) and another where there are no penalties (one-sided risk corridors).[4] We find that for a given level of power, reinsurance reduces insurer risk more than one-sided risk corridors but less than two-sided risk corridors. This result parallels Arrow's (1963) result that the optimal insurance policy for an individual (in the absence of moral hazard) is full coverage after a deductible. We also simulate risk and power under the specific policies being implemented in the Health Insurance Marketplaces and find that while these policies are quite effective at reducing insurer risk, they also result in a significant reduction in power. Interestingly, we show that these policies are dominated by a simple one-sided risk corridor policy according to our measures of insurer risk and incentives.

The paper proceeds as follows. In Section 2 we explain the various risk-reducing policies being implemented in the ACA Health Insurance Marketplaces. In Section 3 we set forth a conceptual framework outlining an optimal insurer risk-reducing policy including consideration of insurer incentives to restrain enrollee medical spending. Section 4 discusses the simulation we use to (1) compare the efficiency of reinsurance and risk corridors and (2) assess the ability of the proposed reinsurance and risk corridor policies to reduce insurer risk. We also describe the dataset of individuals likely to enroll in a Marketplace plan that we construct from the Medical Expenditure Panel Survey dataset (MEPS). In Section 5 we present the results of our simulations. In Section 6 we discuss the results, their implications, and their limitations.

Section 2: Policy Background

Reinsurance: Private reinsurance has been available in the U.S. health insurance market for many years, and government-sponsored reinsurance has been implemented at the national level (e.g. the Medicare Part D program) and the state level (e.g. New York, Idaho). Typically, private reinsurance policies cover only the highest cost cases, while government-sponsored reinsurance reimburses costs starting at much lower thresholds (Bovbjerg et al., 2008; Swartz, 2006). In Part D for example, Medicare reimburses health plans for

[4] While with two-sided risk corridors, the transfers to unlucky plans are financed by the transfers away from the lucky plans, with one-sided risk corridors the transfers are financed by an actuarially fair per capita risk corridor premium assessed to all plans.

80% of any spending on prescription drugs above an enrollee's catastrophic threshold (MedPAC 2012).[5] In 2012 Medicare's reinsurance payments to plans amounted to $14.8 billion, 24% of total Medicare payments to prescription drug plans.

Section 1341 of the ACA creates a reinsurance program for the first three years of the Marketplaces, from 2014 to 2016. For 2014, this program reimburses 80 percent of a health plan's annual costs for an enrollee above an "attachment point" of $60,000 and up to a $250,000 cap (HHS, 2012). Plans are expected to have commercial reinsurance covering costs above $250,000. All covered claims, not just claims for the federally determined essential health benefits, are eligible for reinsurance (Winkleman et al., 2012). This program is financed by a small reinsurance premium, determined by the Treasury and set annually, that is assessed for all covered lives in non-grandfathered health plans in the United States, including some self-funded plans.

Previous empirical research relies on simulations (as opposed to evaluations of existing programs) to study how reinsurance reduces a plan's potential losses from enrolling high-risk individuals. In an SCHIP-eligible population, Sappington et al. (2006) simulated plan profits under varying reinsurance parameters, and found that public reinsurance with an attachment point of $10,000, which is much lower than the attachment point being implemented in the Marketplaces, reduced average plan losses by 40 percent. An additional line of research analyzes the effects of reinsurance on individual-level, rather than plan level, costs and profits. Dow et al. (2010) used data from a Medicare population to demonstrate that even with reinsurance, insurers could still expect to lose $5,400 per individual in the top one percent, and $1,700 per individual in the top three percent of spenders. Thus, incentives for insurers to avoid enrolling high cost patients remain. Zhu et al. (2013) show that reinsurance substantially improves the "fit" of payments to costs at an individual level. Finally, Geruso and McGuire (2014) evaluate the performance of reinsurance with respect to the fit, power, and balance of the payment system. Fit is defined as the R-squared from a regression of each individual's costs on the revenue a plan receives for enrolling her. Power is defined as one minus the portion of the marginal dollar of care reimbursed by the regulator. Balance is defined as the variance of service-specific

[5] In 2014, the catastrophic threshold was $4,550.

measures of power. They find that reinsurance achieves higher "fit" than risk adjustment for any given level of power, suggesting that reinsurance dominates risk adjustment when the regulator's goal is to maximize payment system fit.

Risk Corridors: Risk corridors, also known as aggregate stop-loss reinsurance, have also existed for quite some time in both the private and public sectors (Bovbjerg et al., 2008; Swartz, 2006). In the private sector, aggregate (i.e. risk corridor) protection is included in some reinsurance contracts (Bovbjerg et al., 2008). In the public sector, Arizona's "Healthcare Group" program began in the mid-1980s and included a risk corridor-like policy that reimbursed health plans for costs exceeding an aggregate medical loss ratio of 86 percent annually (AcademyHealth 2007). Symmetric risk corridors that limit plans' profits or losses are also included in Medicare payments to prescription drug plans in Part D, where, after risk-adjustment and reinsurance payments for expenditures by high cost individuals, a plan's losses or profits can trigger risk corridor payments or penalties (MedPAC 2012). Payments to Part D plans for greater than expected costs are financed by recouping funds from plans with greater than expected profits, and the expected net cost of the program to Medicare is zero.

Section 1342 of the ACA establishes a symmetric risk corridor program for the Marketplaces to operate from 2014-16. The program mimics the Part D policy. Under this program a "target amount" of medical expenditures will be calculated for each health insurer's covered risk pool, equivalent to their total premiums collected minus an allowed amount for administrative costs and profits. If a plan's actual expenditures for medical care for its enrollees exceed the target by at least 3 percent, the plan will receive a payment from the risk-corridor program. This program is "symmetric" because if a plan's actual medical expenditures are lower than the target by 3 percent or greater the plan must make a payment to the risk corridors program.

The Medicare Shared Savings and Pioneer Accountable Care Organization (ACO) Programs also include payment models with risk corridors, allowing ACOs to choose between a one-sided and two-sided arrangement. Under the one-sided arrangement, ACOs share up to 50% of savings in excess of a minimum loss ratio (Boyarsky and Parke 2012). Under the two-sided model, ACOs share in 60% of savings, but they will also be liable for up to 60% of costs above expectation. The vast majority (98%) of ACOs have chosen the one-sided model (Centers for Medicare and Medicaid Services 2013).

Section 3: Insurance Principles

3.1 Risk Aversion and Risk Neutrality

In conventional theory of the firm, the firm is assumed to be risk neutral, the rationale being that investors are able to protect themselves against any firm-specific risk by diversification in their investment portfolio.[6] In practice, however, while firms are owned by shareholders who can diversify to minimize their risk, they are managed by employees. When managers are risk-averse and their incomes are tied to the value of the firm, firms may behave as if they are risk-averse. As a result, the optimal manager contract involves some portion of pay being tied to firm performance, with the exact portion being determined by the trade-off between motivating managers to maximize the value of the firm and minimizing changes to firm behavior that stem from manager risk aversion (Fama and Jensen 1983). Empirical evidence on the correlation between manager pay and firm value suggests that these types of contracts have increased in prevalence over time over time, largely due to the increasing importance of stock options (Hall and Liebman 1998). Correlation between manager pay and firm value implies that managers may seek to avoid risk.[7]

Risk assumes special significance for firms in the insurance industry. Financial risk from health care expenses creates demand for health insurance. The law of large numbers reduces the risk of large losses at the insurer level by pooling the risks of many risk-averse individuals, improving welfare while simultaneously decreasing the insurer's own uncertainty with each additional enrollee. However, some risks are not mitigated by large numbers. For example, in new markets, such as the ACA Marketplaces, the properties of the risk pool may not be well-known. Under these circumstances managers at health insurance companies also face

[6] See Rothschild and Stiglitz (1976) for justification of this assumption in the context of insurance. Bulow (2004) presents an argument justifying this assumption in the context of the risk of pharmaceutical patent litigation.
[7] Conceivably, managers could hedge against the risk present in their pay packages on their own. However, given that changes in firm value are quite large (Hall and Liebman (1998) report a standard deviation of changes in firm value of around 32% or about $700 million), it seems likely that liquidity constraints will prevent them from fully hedging against this kind of risk.

the risk of mispricing insurance policies or selecting an unexpectedly high cost group of initial enrollees.[8] Following from the discussion above, while owners can hedge away risk, firm managers are likely to be making decisions regarding the pricing of contracts and whether or not to enter new markets. Because managers' pay is tied to firm value (Hall and Liebman 1998), the firm's choices are likely to reflect manager risk aversion.

In practice, insurers exhibit risk-averse behavior in other ways as well. Risk-corridor-like insurance products have historically been purchased by insurers in the private market (Bovbjerg et al., 2008; Swartz, 2006). There would be no market for such policies if insurers were risk neutral. The loading factor (the difference between medical claims paid by the insurer and premium revenue) has been estimated to be around 40% higher for very small groups than for very large groups (Gruber 1998). While this difference could be due to large fixed costs of insuring a group of individuals, at least some portion of it may also reflect aversion to the increased uncertainty associated with small groups. Finally, a long line of research in the actuarial literature calculates a "risk premium" in order to incorporate it into the loading factor on an insurance policy (see Kahane (1979), and Christofides and Smith (2001) for some examples of this literature). Most of these studies relate the "cost" of risk to be priced into the insurance premium to the standard deviation of the cost distribution, a measure we will use later. For all of these reasons, the following analysis takes as a point of departure that the firms considering participating in health insurance Marketplaces act as though they are risk-averse.

3.2 Risk Measures

We measure insurer risk in two ways. The first is the standard deviation of the distribution of potential outcomes. This measure is proportional to what is known as the "risk premium," or the dollar amount an agent is willing to pay to eliminate uncertainty, for an individual with Constant Absolute Risk Aversion Utility. The second measure of risk is the likelihood of a large loss. This measure is proportional to the risk premium of an individual who faces a large penalty for incurring a large loss. The measure is

[8] As has become obvious in recent months, insurers also face political risk where policies and regulations that affect the risk pool can change after insurers set prices.

motivated by managers or owners/investors facing a large penalty for being forced to declare bankruptcy or for depleting the insurer's reserves.

We define potential outcomes for insurers using the distribution of expected costs of the insurer's enrollees. Our construction of costs includes only medical and pharmaceutical expenditures and ignores administrative costs, as these fixed and predictable costs are non-random and do not affect insurer risk. We treat the mean of the cost distribution as the insurer's expected cost per enrollee, and we assume that any outcome below this value results in insurer "profits" and any outcome above this value results in insurer "losses."[9] Figure 1 illustrates this cost distribution. Essentially, every year an insurer receives a draw from this distribution. If an insurer receives a draw from the left side of the distribution, it will earn unexpected profits in that year. If the insurer receives a draw from the right side of the distribution, it will experience unexpected losses.

3.3 Theory of insurance for insurers

The seminal papers establishing the theory of insurance in health economics are Arrow (1963) and Zeckhauser (1970). Arrow established that, with a limited budget, the optimal insurance policy is full coverage after a deductible. In Arrow's model, individuals have diminishing marginal utility in non-medical consumption and uncertainty about their future health status and, thus, their medical expenses. Under these assumptions, individuals value an extra dollar of coverage against medical expenses more as the potential expense gets larger. Therefore, coverage for large expenses provides larger welfare gains than coverage for small expenses. However, full coverage after a deductible is not optimal when insurance affects individual behavior. Zeckhauser (1970) shows there is a fundamental trade-off between risk protection and moral hazard in insurance and derives an expression for the optimal coinsurance rate as a function of the price elasticity of demand for medical care.

[9] This definition of "profits" and "losses" comes from an assumption that insurers price their insurance policies at the average expected cost of potential enrollees. Such pricing is implied by an assumption of perfect competition.

In the context of protecting health insurers from risk, if we assume no moral hazard, Arrow's principle of the optimality of full coverage after a deductible implies that it is inefficient to use reinsurance to provide risk protection. The logic for this argument is as follows: because reinsurance protects against individual-level losses, some plans that *ex-post* have an outcome in the left-hand side of the cost distribution (i.e. positive profits) will receive reinsurance payments if they have one or two high cost cases and many low cost cases. At the same time, some plans that *ex-post* have an outcome in the right-hand side of the cost distribution (i.e. aggregate losses) will receive no reinsurance payments if they have many cases whose realized costs are only slightly above the expected cost. A more efficient policy would mimic Arrow's optimal insurance policy of full coverage after a deductible by reimbursing only plans incurring large aggregate losses. This type of policy has the benefit of using fewer dollars to achieve greater reductions in the variance of the profit distribution and the probability of a large loss for plans. This is exactly how risk corridors operate.[10]

Section 3.4: Power and Incentives for Efficiency

Insurer risk reduction is clearly not the only, or even the principle, objective of the regulator. The regulator may also wish to encourage insurers to use the tools available to them to restrain spending in order to keep prices low. It is well-known that cost-based provider payment systems, also known as fee-for-service systems, are likely to result in overuse of medical services (Ellis and McGuire 1986). Cost-based insurance market payment systems are likely to have similar undesirable effects. Most policies that reduce insurer risk, including reinsurance and risk corridors, result in payment systems that are partially cost-based. Thus, the regulator faces a trade-off between reducing insurer risk and providing insurers with the incentive to control costs.

To incorporate this trade-off into our framework, we draw on contract theory and use the concept of the *power* of a payment system (Geruso and McGuire 2014, Laffont and Tirole 1993). Under a contract, when

[10] Risk adjustment is another policy related to insurer risk that is often discussed along with risk corridors and reinsurance. However, while risk adjustment has important effects on the mean of an insurer's distribution of expected costs, its effects on the variance of the distribution are minimal. Because all of our measures of risk are based in some way on the variance of the cost distribution and are unrelated to the mean of the distribution, we abstract from risk adjustment through much of this paper.

a principal's payments to an agent are tied to the agent's costs so that the insurer's marginal price of an additional dollar of an enrollee's healthcare utilization is reduced, the contract is low-powered, weakening an insurer's incentives to control costs. When payments are independent of costs, however, the contract is high-powered with greater cost control incentives.

We follow Geruso and McGuire (2014) and define power as the share of costs borne by a health plan at the margin. For an individual enrollee, this share is characterized by the derivative of the payment a plan receives for enrolling the individual with respect to her utilization, $\frac{dp_i}{dx_i}$. In a setting where an insurer is fully reimbursed for each dollar spent on an enrollee's care, this derivative will be 1. In a setting where a plan is paid a fixed capitation fee for each enrollee, on the other hand, the derivative will always be equal to 0. At a population level, we define power (ρ) as:

$$\text{Power} \equiv \rho = 1 - \frac{1}{N}\sum_{i=1}^{N} \frac{dp_i}{dx_i}$$

This measure of power is thus the share of the marginal dollar of an individual's spending borne by the insurer averaged over all individuals in a plan. A fully high-powered contract has $\rho = 1$, whereas a completely low-powered contract has $\rho = 0$. Here we assume that more power is better and that any sacrifice of power away from 1.0 introduces inefficiency. While this assumption may not always be true in practice, it provides a reasonable benchmark for analyzing the relative efficiency of risk-reducing policies. [11]

Both reinsurance and risk corridors tie an insurer's payments to its costs (at least in part), and thus affect power. On one hand, reinsurance pays plans for some portion of each additional dollar spent on a specific individual whose costs exceed some threshold, weakening the insurer's incentive to manage the utilization of these high cost enrollees. On the other hand, risk corridors pay plans for some portion of each

[11] While it is clear that a system where insurers are fully reimbursed for every dollar spent on their enrollees' care provides too little incentive to constrain utilization, a system where insurer payments and costs are independent may lead to *under-utilization* (Ellis and McGuire 1986; Newhouse 1996). In this case the optimal power will be less than 1.0. In this case, analyses like those conducted here can help identify the risk corridor/reinsurance policies that minimize risk for any desired payment system policy.

additional dollar spent on *any* individual once total spending by the plan exceeds some threshold, weakening the insurer's incentive to constrain every enrollee's costs once that threshold has been crossed. Given that both are in operation in the health insurance Marketplaces, it is likely that the power of the contract between the Marketplace and the insurers will diverge from 1.

Section 4: Data and Methods

In the following empirical analysis of these principles we first simulate a distribution of outcomes for plans participating in a Marketplace to calculate baseline risk measures. We then apply reinsurance and risk corridors to the distribution, recalculate the risk measures, and calculate our measure of power under each policy to determine how each policy affects insurer risk and the incentive for insurers to restrain spending among their enrollees.

Section 4.1: Data on the Marketplace Population and Health Care Spending

The Medical Expenditure Panel Survey (MEPS) is a large, nationally representative survey of the civilian non-institutionalized U.S. population with information on approximately 33,000 individuals annually. We identify a Marketplace-eligible population following methods in McGuire et al. (2013). Pooling MEPS data from Panels 9 (2004/5) through 14 (2009/10), we select a population of individuals and families eligible for enrollment in Marketplaces based on income, insurance, and employment status. Specifically, we select adult, non-elderly individuals (aged 18-64) in households earning at least 138 percent of the federal poverty level (FPL) and children in households with income of at least 205 percent of FPL. Selection criteria into the Marketplace population, as defined by the ACA, include individuals living in households in which an adult was: ever uninsured, a holder of a non-group insurance policy, self-employed, employed by a small employer, or paying an out-of-pocket premium for their employer-sponsored health insurance (ESI) plan that is deemed to be unaffordable. If an individual meets the selection criteria in at least one of the two survey years, she is included in the sample. The dataset comprises 44,210 "Marketplace-eligible" individuals, 11,773 of whom have only one year of data and 32,437 of whom have two years of data, generating a total sample of 76,647 person-years.

The MEPS includes data on total health care expenditures for each individual during each year. It also includes information such as diagnoses from all of the medical events that result in those expenditures (i.e. office visits, hospital stays, prescriptions filled, etc). MEPS data understate health expenditures (Sing et al., 2002; Aizcorbe et al., 2012; Zuvekas and Olin, 2009). Discrepancies are driven both by underreporting of healthcare utilization and under-representation of high-expenditure cases due to the exclusion of patients who are institutionalized or hospitalized longer than 45 days. Zuvekas and Olin (2009) suggest that total expenditures be inflated by a factor of 1.09 for individuals with an inpatient claim and by a factor of 1.546 for all other individuals. We adopt this correction, inflating expenditures of the individuals in our sample as directed.

Section 4.2: Cost Distribution

The simulated cost distribution describes an insurer's average cost per enrollee in all potential states of the world and the likelihood of each state. In order to simulate the insurer's cost distribution we first fix the size of the plan at Q enrollees. We take M random samples of Q individuals from our sample of $N = 76{,}647$ Marketplace-eligible individuals. For each random sample, we calculate the average cost of the Q chosen individuals, $\bar{x}_m$. The set of average costs from all draws from the Marketplace-eligible sample forms our simulated cost distribution,

$$f(\bar{x}) = \Pr(\bar{x}) = \frac{\sum_{m=1}^{M} \mathbf{1}(\bar{x} = \bar{x}_m)}{M}.$$

We use this simulated distribution to test the effects of reinsurance and risk corridors on risk and power.

Section 4.3: Reinsurance

Our methods for modeling reinsurance mimic the methods used in Zhu et al. (2014). Let x_i be individual i's total annual cost to the insurer. Let $\hat{x}$ be the reinsurance threshold above which costs are reimbursed. Finally, let δ be the rate at which costs are reimbursed. The reinsurance payment received by the insurer when enrolling individual i, re_i, is defined as follows:

$$re_i = \begin{cases} 0 & \text{if } x_i < \hat{x} \\ \delta(x_i - \hat{x}) & \text{if } x_i \geq \hat{x} \end{cases}$$

We assume that plans' paid claims are equal to total claims; in other words, we assume that the plan covers all health care costs incurred by an individual during a given year. We also assume that reinsurance is funded through a per capita, actuarially fair reinsurance fee collected for each Marketplace enrollee.[12] The fee, denoted ref, is equal to the average reinsurance payment for the entire population:

$$\mathrm{ref} = \frac{1}{N}\sum_{i} \mathrm{re}_i$$

This ensures that reinsurance will be budget neutral.

We apply reinsurance to the simulated cost distribution as follows. First, we determine re_i for each individual in the Marketplace-eligible sample. We then calculate ref and redefine each individual's cost to the plan as $x_i^{re} = x_i - \mathrm{re}_i + \mathrm{ref}$. Finally, we simulate the insurer's cost distribution using the same methods described in Section 4.2 but using the new definition of insurer costs, x_i^{re}. The plan's simulated cost distribution under a policy of reinsurance is thus:

$$g(\bar{x}^{re}) = \Pr(\bar{x}^{re}) = \frac{\sum_{m=1}^{M} \mathbf{1}(\bar{x}^{re} = \bar{x}_m^{re})}{M}$$

Section 4.4: Risk Corridors

Risk corridors transfer funds to an insurer if the sum of covered health care costs of the insurer's enrollees is greater than a fixed percent of a target. In the risk corridor policy proposed for the Marketplaces, the target is defined as an insurer's total premium revenues minus some combination of administrative costs and profits. To simplify, we define the target as the mean of the average cost distribution.[13] Thus, if an insurer's realized average per capita cost is greater than the expected average cost (the target) by a defined minimum percentage, the risk corridor will reimburse the insurer for a portion of its costs according to the risk corridor cost-sharing parameters.

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[12] Note that this is different from how reinsurance will be funded in practice (described in section 2). We do this to allow for an "apples-to-apples" comparison of reinsurance and risk corridors by forcing them both to be "self-funding."

[13] Again, only factors that involve uncertainty impact risk corridor payments and our risk measures. Administrative costs and profits affect the level of outcomes but not the other moments of the outcome distribution (i.e. variance), so they don't matter for risk corridor payments or for our risk measures. This assumption could also by justified by assuming perfect competition and no administrative costs.

To apply risk corridors to the simulated cost distribution, we first construct the cost distribution using the methods described in Section 4.2. Let $\bar{p}$ be the mean of the simulated cost distribution. Thus the target is:

$$\bar{p} = \frac{1}{M}\sum_{m=1}^{M} \bar{x}_m$$

Now we introduce three new parameters: average plan costs as a percent of the target, $\alpha_m = \frac{\bar{x}_m}{\bar{p}}$; the upper threshold, $\bar{\alpha}$; the lower threshold, $\underline{\alpha}$; and the portion of costs reimbursed, θ. Risk corridor payments are based entirely on the value of α_m implied by the insurer's draw from the expenditure distribution. Specifically, the risk corridor gives the insurer the following transfer:

$$t(\alpha_m) = \begin{array}{cc} \theta(\bar{x}_m - \bar{\alpha}\bar{p}) & \text{if } \bar{\alpha} < \alpha_m \\ 0 & \text{if } \underline{\alpha} < \alpha_m < \bar{\alpha} \\ \theta(\bar{x}_m - \underline{\alpha}\bar{p}) & \text{if } \alpha_m < \underline{\alpha} \end{array}$$

Suppose that the risk corridor reimburses plans for 50% of costs above 108% of the target. In this case, $\bar{\alpha} = 1.08$ and if for a given plan $\alpha > 1.08$ then the plan will receive a transfer of $0.5(\bar{x} - 1.08\bar{p})$. More generally, if an insurer gets a "bad" ("good") draw from the expenditure distribution such that α_m is large (small), it will receive a positive (negative) transfer from the regulator to offset some portion of its losses.

We calculate the insurer's α_m for each draw m, and use α_m along with the above definition to determine $t(\alpha_m)$. We then redefine the insurer's cost to the plan for enrolling individual i in state of the world m as $x_{im}^{rc} = x_i - t(\alpha_m)$. Finally, we use this new definition of costs to construct the new cost distribution with risk corridors:

$$h(\bar{x}^{rc}) = \Pr(\bar{x}^{rc}) = \frac{\sum_{m=1}^{M} \mathbf{1}(\bar{x}^{rc} = \bar{x}_m^{rc})}{M}.$$

With large M, the cost distribution will be symmetric. If $\underline{\alpha} = 1 - (\bar{\alpha} - 1)$, the risk corridor transfer, $t(\alpha_m)$, will be equal to zero in expectation. In other words, the risk corridor policy is "budget neutral" in expectation.

For the risk corridor policy described thus far, the positive transfers *to* plans with unexpectedly high costs are funded by transfers *from* plans with unexpectedly low costs. We refer to this type of risk corridor policy as two-sided risk corridors.

The transfers to the high cost plans could also be funded via an actuarially fair premium assessed to *all* plans in the market. We refer to this type of policy as a one-sided risk corridor, and we simulate an additional version of the cost distribution that reflects the effects of such a policy. Under a one-sided risk corridor policy, the regulator pays insurers the following transfer:

$$t(\alpha_m) = \begin{cases} \theta(\bar{x} - \bar{\alpha}p) & \text{if } \bar{\alpha} < \alpha_m \\ 0 & \text{if } \alpha_m < \bar{\alpha} \end{cases}$$

Insurers are also assessed an actuarially fair per capita fee, denoted rcf. We redefine α_m to incorporate this fee: $\alpha_m^{os} = \frac{\bar{x}+rcf}{p}$.[14] The fee is equal to the expected value of the transfer, taken over all potential states of the world:

$$rcf = \frac{1}{M}\sum_{m=1}^{M} t(\alpha_m^{os}) \qquad (1)$$

Note that because the transfer is a function of α_m^{rc}, rcf is a function of α_m^{rc}. Recall that α_m^{rc} is also a function of rcf. This implies that for each $\bar{\alpha}$ there is an equilibrium value for rcf that satisfies (1).

To apply one-sided risk corridors to the simulated cost distribution, we redefine insurer costs as $x_{im}^{os} = x_i - t(\alpha_m^{os}) + rcf$. Because α_m^{os} is a function of rcf and rcf is a function of α_m^{os}, we use an iterative procedure to find the value of α_m^{os} that causes (1) to hold. Finally, we use the new definition of plan costs to construct the new cost distribution under one-sided risk corridors:

$$h^{os}(\bar{x}^{os}) = \Pr(\bar{x}^{os}) = \frac{\sum_{m=1}^{M} \mathbf{1}(\bar{x}^{os} = \bar{x}_m^{os})}{M}.$$

[14] The risk corridor policy in the ACA establishes that α be based on insurer costs *net of all other policies*. This implies that α is based on costs after reinsurance is applied or, in this case, after the fee is assessed. Without this condition, the policy would not be budget neutral.

Section 4.5: Estimation of Risk

As discussed in Section 3.2 above, we quantify insurer risk in two ways. The first is the standard deviation of the expected cost distribution, where risk is increasing in the standard deviation. The second measure characterizes the probability of a large loss. It is termed the "value at risk," in the finance literature, and is defined as the Yth percentile of the expected cost distribution. In our case, larger values of the "value at risk" imply higher risk.

Section 4.6: Estimation of Power

As noted above, we measure power as the portion of the marginal dollar spent on an average enrollee's health care by the health plan:

$$\text{Power} \equiv \rho = 1 - \frac{1}{N}\sum_{i=1}^{N}\frac{dp_i}{dx_i}.$$

For the reinsurance and risk corridor policies we simulate, there is no closed form solution for this definition of power, so we estimate it via simulation. First, we specify plan revenues, p_{im}, as the sum of plan premiums, net reinsurance payments, and (net) risk corridor payments:

$$p_{im} = \bar{p} + re_i - ref + t(\alpha_m)$$

We assume that premiums are constant for all individuals and are set equal to the average cost in the Marketplace-eligible population as they would be in a perfectly competitive market with zero profits.[15]

Next, we estimate $\frac{1}{N}\sum_{i=1}^{N}\frac{dp_i}{dx_i}$ by simulation. The derivative of plan payment with respect to utilization, $\frac{dp_i}{dx_i}$, describes how much plan payments change given a \$1 increase in utilization. Note that this value is defined by the structural rules of the payment system, not by any behavioral parameters. Reinsurance and risk corridor payments are functions of realized costs, so any shift in realized costs will affect these payments. We can thus determine the derivative in each policy environment by simulating a decrease in each

[15] The ACA allows for premiums to vary by age, geography, and smoking status. We abstract from these allowances here, as they are unrelated to utilization, and, thus, to power. Note that in this case the premium is equal to the risk corridor "target."

individual's spending and then using the payment system rules described above to determine the corresponding change in plan payments. For purposes of the simulation, we assume that when an insurer reduces utilization, the premium, reinsurance fee, and risk corridor target remain constant. We do this because our goal is to characterize the plan's *incentive* to control costs, not to simulate equilibrium outcomes when plans are able to achieve cost reductions. We calculate this derivative for each draw from the cost distribution.

More specifically, for each policy we start by calculating p_{im} for each draw from the Marketplace-eligible sample. We then implement an insurer reduction of 5% of each individual's health care costs for each draw, i.e. $x_i^* = 0.95x_i$. We then re-simulate reinsurance and risk corridors where costs are equal to x_i^* instead of x_i, generating new reinsurance and risk corridor payments (re_i^* and $t(\alpha_m^*)$). Premiums and reinsurance and risk corridor fees remain the same. We use these values to re-calculate plan revenues, $p_{im}^* = \bar{p} + re_i^* - ref + t(\alpha_m^*)$. Power is then calculated as

$$\hat{\rho} = 1 - \frac{1}{M}\sum_{m=1}^{M}\frac{1}{N}\sum_{i=1}^{N} D_{im}\frac{p_i - p_i^*}{x_i - x_i^*}$$

where D_{im} is equal to 1 if individual i was chosen in draw m and zero otherwise. This characterization captures the expected change in plan revenues for an incremental change in plan costs and leads to a measure of power, the portion of the marginal dollar of an enrollee's health care spending born by the plan.

Section 4.7: Simulation Methods

We perform two types of simulations. First, we compare the performance of reinsurance and risk corridors with a simplified form of each policy. For risk corridors, we set $\theta = 1$. Effectively, the simplified policy provides "full coverage after a deductible." Similarly, we simplify the definition of reinsurance by setting $\delta = 1$. Thus, the policy reimburses plans for 100% of an individual's costs above a threshold. These simplifications compare policies based on a similar reimbursement structure. We allow the reinsurance and risk corridor cutoffs (i.e. $\bar{\alpha}$ and $\hat{x}$) to vary over a wide range. For reinsurance, we allow the cutoff to vary between \$0 and \$375,000. For risk corridors we allow the cutoff to vary between 100.1% and 130% of the target. We also allow risk corridors to be either two-sided or one-sided, and for two-sided risk corridors we set $\underline{\alpha}$ by reflecting $\overline{\alpha}$ across the target: $\underline{\alpha} = 1 - (\overline{\alpha} - 1)$. For each simulation, we calculate our measure of power and each of the risk measures described in Section 4.5 and 4.6. We then compare the level of risk faced by an insurer generated by a reinsurance or risk corridor policy with a given level of power.

The second set of simulations evaluates the performance of the policies implemented in the Marketplaces from 2014-2016. We simulate each proposed policy (reinsurance and risk corridors) on its own and combined in the full package of risk-reducing policies. We adapt our general framework to the actual policies being implemented in the Marketplaces. Both the ACA reinsurance and risk corridor policies are slightly more complicated than those modeled above in that they have multiple thresholds and the portion of costs reimbursed varies across thresholds. In the Marketplaces risk corridor transfers are defined as follows:

$$t(\alpha_m) = \begin{cases} 0.025p_n + 0.8(c_k - 1.08p_n) & \text{if } 1.08 < \alpha_m \\ 0.5(c_k - 1.03p_n) & \text{if } 1.03 < \alpha_m < 1.08 \\ 0 & \text{if } 0.97 < \alpha_m < 1.03 \\ 0.5(c_k - 0.97p_n) & \text{if } 0.92 < \alpha_m < 0.97 \\ -0.025p_n + 0.8(c_k - 0.92p_n) & \text{if } \alpha_m < 0.92 \end{cases}$$

Similarly, reinsurance payments will be paid according to the following definition:

$$re_i = \begin{cases} 0 & \text{if } x_i < 60{,}000 \\ 0.8(x_i - 60{,}000) & \text{if } 60{,}000 < x_i < 250{,}000 \\ 152{,}000 + 0.85(x_i - 250{,}000) & \text{if } 250{,}000 < x_i \end{cases}$$

All results presented below are from simulations of a plan with 5,000 enrollees, and the cost distribution is simulated with 10,000 draws from the Marketplace-eligible sample. Similar results from simulations of a plan with 20,000 enrollees can be found in the appendix.

Section 5: Results

Section 5.1: Reinsurance vs. Risk Corridors

Figure 2 plots "risk" measured as the standard deviation of the insurer's cost distribution, under reinsurance or risk corridor policies with a given level of power. Power is increasing along the x-axis and insurer risk is increasing along the y-axis. For any level of power, the Figure shows the corresponding level of insurer risk. For example, both reinsurance and one-sided risk corridors with power equal to 0.8 generate a cost distribution with a standard deviation of about $90. On the other hand, two-sided risk corridors with power equal to 0.8 generate a cost distribution with a standard deviation around $120. This implies that reinsurance and one-sided risk corridors out-perform two-sided risk corridors according to this measure of insurer risk: they both achieve larger reductions in insurer risk for any given level of power.

Figures 3 and 4 show that this result more-or-less holds when measuring "value at risk." Figure 3 shows power and "value at risk" using the 95^{th} percentile of the cost distribution to quantify insurer risk. Reinsurance and one-sided risk corridors out-perform two-sided risk corridors according to this metric because both policies always achieve larger reductions in insurer "value at risk" for any given level of power. Additionally, one-sided risk corridors outperform reinsurance according to this measure of insurer risk. Figure 4 shows similar results for the 99^{th} percentile of the cost distribution, though with this measure the performance of reinsurance and two-sided risk corridors is quite similar.

These figures imply that one-sided risk corridors weakly out-perform the other policies according to all measures. Additionally, the relative performance of one-sided risk corridors can be quite significant. Considering "value at risk," one-sided risk corridors can achieve the same level of insurer risk reduction with a policy generating power of 0.8 as a reinsurance policy with power of 0.25-0.4 and a two-sided risk corridor policy of 0.25. To put these levels of power in context, these results imply that the incentive consequences from using two-sided risk corridors or reinsurance rather than one-sided risk corridors are equivalent to the consequences from choosing a payment system that reimburses insurers for 20% of all spending to a system reimbursing insurers for 60-75% of all spending.

Section 5.2: Proposed Marketplace Policies

Results for policies being implemented in the Marketplaces from 2014-2016 can be found in Table 2. Each policy reduces insurer risk substantially. When simulated separately, the policies reduce the standard deviation of the insurer's cost distribution by $33-$36, or about 25%. When the policies are implemented together, as they are in the Marketplaces, the risk reduction is increased to $52, or about 38%. Both policies also have substantial effects on the "value at risk," reducing the 95th percentile of the cost distribution by around $100 when implemented together.

The final row of Table 2 reports power. Reinsurance alone is associated with high power, around 0.89. Two-sided risk corridors, on the other hand, decrease power to 0.68. When the policies are implemented together, power is similar to when the risk corridor policy is implemented in isolation.

To put the performance of the Marketplace policies in context, Figures 2-5 plot the measures of insurer risk and power under the full "hybrid" Marketplace policy (reinsurance and two-sided risk corridors) along with the simulated counterfactual policies discussed in Section 5.1. In each figure, the black square represents the combination of power and risk under the hybrid policy. The figures make it clear that "full coverage after a deductible," i.e. the one-sided risk corridor, generates lower insurer risk for the same level of power as the hybrid policy. The gain also appears to be non-trivial: a $20 reduction in the standard deviation, an $85 reduction in the 95th percentile, and a $125 reduction in the 99th percentile of the insurer's cost distribution. Thus, according to our measures of risk and power, the simple one-sided risk corridor dominates the hybrid Marketplace policy. Additionally, according to these measures, the simple "full coverage after a deductible" reinsurance policy also dominates the hybrid policy.

Section 6: Discussion

In a simulated population of Marketplace insurance enrollees, for any given level of power, we find that simple, "full coverage after a deductible" one-sided risk corridors provide a greater reduction in insurer risk than reinsurance or two-sided risk corridors. Similarly, reinsurance results in lower risk than two-sided risk corridors. Additionally, these simulations show that a simple one-sided risk corridor outperforms the risk-reducing policies being implemented in the Marketplaces consisting of a combination of partial coverage reinsurance and two-sided risk corridors. These results imply that the trade-off between insurer risk protection and incentives to contain costs leans in favor of one-sided risk corridors.

It was not clear *ex ante* whether reinsurance or risk corridors would perform better. While an individual-level policy like reinsurance affects insurer incentives to constrain spending among individuals whose costs are likely to exceed the threshold, such a policy has no effect on insurer incentives to limit spending among all other enrollees. Considering that the costs of only 0.45% of our sample exceed $60,000 (the Marketplace reinsurance policy threshold) the average effect of reinsurance on power may be minimal in any given state of the world. However, reinsurance, unlike risk corridors, affects insurer incentives for that small group of individuals in every state of the world. Risk corridors, on the other hand, affect insurer incentives for every enrollee but only in the rare case that the plan gets a bad draw from the cost distribution and incurs a large loss. Our simulations show that when measuring insurer incentives using the concept of power, plan-level one-sided risk corridor policies outperform individual-level reinsurance policies.

These results confirm the parallel between individual insurance and insurance for insurers. Insurer risk is based on plan-level rather than individual-level outcomes. As such, a policy that focuses on eliminating extreme plan-level outcomes (risk corridors) is likely to maximize risk reduction while minimizing the effect on insurer incentives for cost containment more efficiently than a policy focusing on eliminating extreme individual-level outcomes (reinsurance). Risk corridors only result in positive transfers to a plan if the plan loses a substantial amount of money. Reinsurance, on the other hand, results in positive transfers in all parts of the insurer's profit distribution because, regardless of whether the insurer has unexpectedly low costs and high profits, if the insurer has a few high cost cases it will still get a payment from the regulator. Many of these payments are "wasteful" in that they reduce the power of the payment system while having little or no effect on insurer risk.

The simulations also expose the shortcomings of two-sided risk corridors which finance the payments to plans with high costs through transfers from plans with low costs. While these two-sided policies seem "fair" they come with a cost: two-sided risk corridors limit insurer incentives to restrain utilization among both "winners" (plans with low costs) and "losers" (plans with high costs). In both cases, the price to the insurer of the marginal dollar spent on an enrollee's health care is reduced by the two-sided risk corridor. With respect to the standard deviation measure of risk, this presents a trade-off between additional risk reduction and additional reductions in power. Our results show that the extra reduction in power exceeds the gains in risk reduction, generating our result that one-sided risk corridors outperform two-sided risk corridors. Somewhat surprisingly, the simulations also show that the additional reduction in power caused by the two-sided risk corridors causes them to also be outperformed by individual-level reinsurance policies.

These simulation results are subject to a few caveats. First, while our simulations accurately reflect the trade-off between insurer risk reduction and insurer incentives to constrain spending, they do not fully reflect the trade-off between insurer risk reduction and social welfare. Because the concept of power only describes the *incentives* of the insurer rather than actual behavior, it represents only an approximation of the efficiency consequences of these policies. Insurer behavior in response to this incentive may be extreme or quite limited, depending on the cost to the insurer of efforts to constrain enrollee spending. For example, one could imagine a situation where the cost to the insurer of modifying a high-cost enrollee's total medical spending is extremely high. In such a situation, an insurer may never respond to a change in its incentive to constrain that enrollee's spending, and the social cost of reimbursing an insurer for that enrollee's spending would be zero. In some sense, then, power represents only the height of the Harberger triangle describing the welfare loss from reinsurance or risk corridors. While the other side of the triangle is necessary for a complete welfare analysis, any welfare loss associated with a given policy will be proportional to power, allowing us to use power to approximate the welfare consequences of these policies. Recovering the behavioral response of insurers to the shifts in incentives caused by these types of policies represents an important area for future research.

Second, while the simulations suggest that when the regulator's goal is to limit insurer risk for a given level of power one-sided risk corridors dominate two-sided risk corridors and reinsurance, the regulator may also have other goals. For example, the regulator may wish to limit the incentive for insurers to "cream-skim" low cost enrollees. Reinsurance and risk corridors have dramatically different implications for insurers' incentives to engage in this type of behavior. Reinsurance effectively redistributes costs from high cost individuals to low cost individuals, which dramatically weakens insurer incentives to select low cost individuals (Zhu et al. 2013, Geruso and McGuire 2014). Risk corridors, on the other hand, do not affect the heterogeneity of costs across the population of potential enrollees and thus do not affect the plan's incentives to select against sicker enrollees.[16] This suggests that, while risk corridors dominate reinsurance with respect to reducing insurer risk, the optimal amount of reinsurance is likely to be greater than zero.

Risk corridors and reinsurance may also differ in how they affect an insurer's premium-setting incentives. If consumers are inertial in their choice of health plans, insurers may optimally choose to engage in "invest then harvest" strategies where they compete to be the "loss leader" in the first year of the operation of the market in order to gain market share (Ericson 2014). In subsequent years, insurers can then ratchet up the price of their policies because consumer switching costs cause price sensitivity among incumbent enrollees to be quite low. With risk corridors, these strategies become more attractive to insurers because they limit the losses incurred from underpricing of policies during an individual's first year of enrollment. Two-sided risk corridors, on the other hand, may limit the attractiveness of these strategies by transferring money away from insurers earning large profits, reducing the surplus insurers can extract by ratcheting up prices in later years.

The implications of these unintended consequences of risk corridor policies represent important topics for future research. Additionally, while this paper demonstrates the potential value of risk corridors through a conceptual framework, empirical evidence on their effects in practice is needed. The effects of the risk corridor policies that have been implemented in Medicare Part D and in the early years of the ACA Marketplaces represent excellent opportunities for studying the effects of this policy in practice in the near future.

[16] Risk corridors can affect selection incentives if the contribution of low cost individuals to the variance of the distribution is different from the contribution of high cost individuals. If this is the case, then risk corridors do affect the incentives of risk-averse insurers to inefficiently select low cost individuals because they will seek to do so for two reasons: (1) to shift the mean of the cost distribution to be as small as possible and (2) to decrease the variance. of the distribution as far as possible. Because risk corridors affect the variance of the distribution and the effects of selection efforts on the variance of the distribution, they can affect selection incentives. However, selection incentives via the variance of the distribution are likely to be second-order to the incentives via the mean of the distribution.

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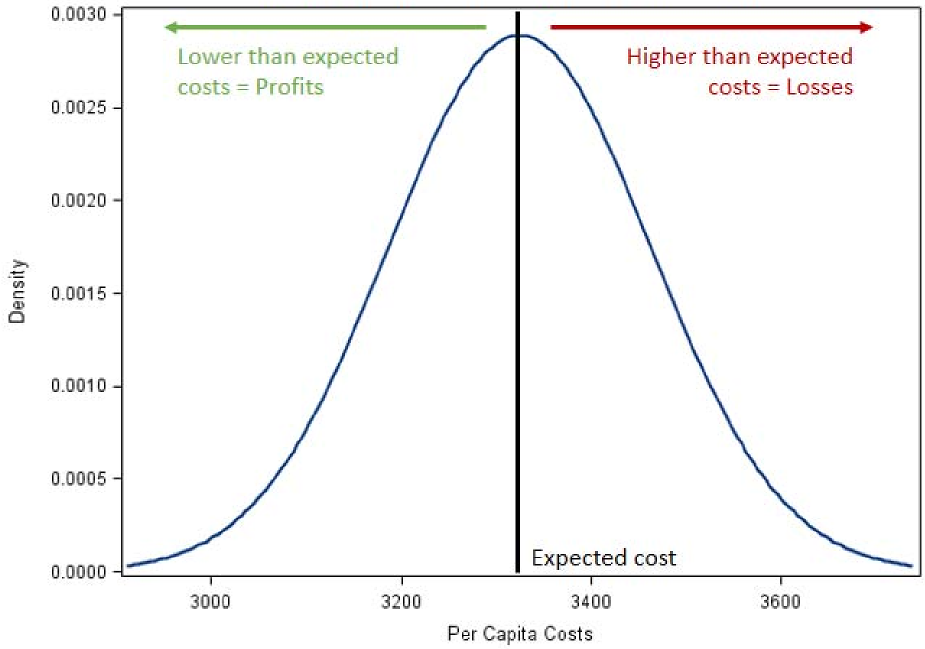
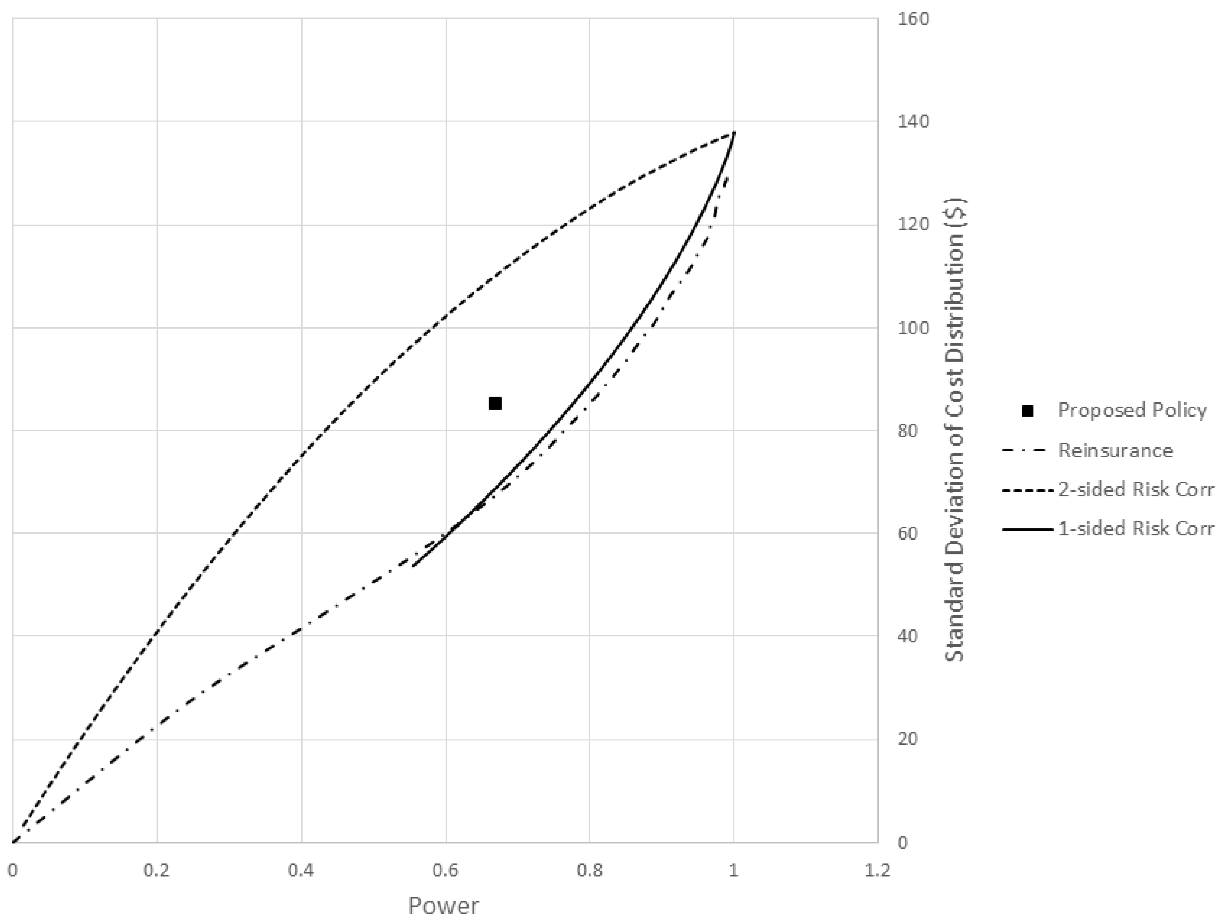
Figure 1: Insurer's Distribution of Expected Costs



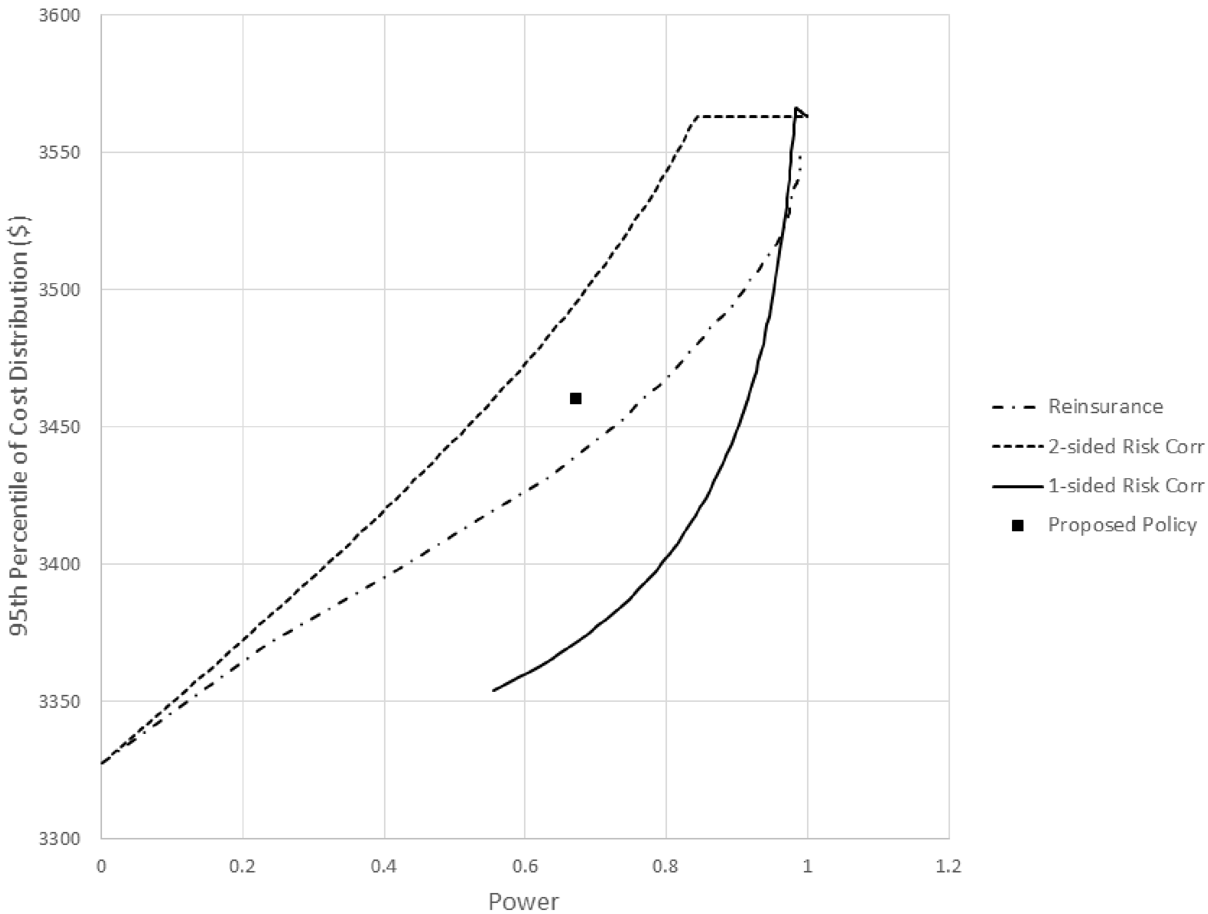
Notes: This figure illustrates the expected cost distribution faced by insurers. Possible realizations of per capita costs are on the x-axis, and the density is on the y-axis. The expected cost is the mean of this distribution. We assume that prices are set such that any outcome to the left of the mean (lower than expected costs) result in positive profits and any outcome to the right of the mean (higher than expected costs) result in losses.

Figure 2: Power and Standard Deviation of Cost Distribution with Reinsurance and Risk Corridors



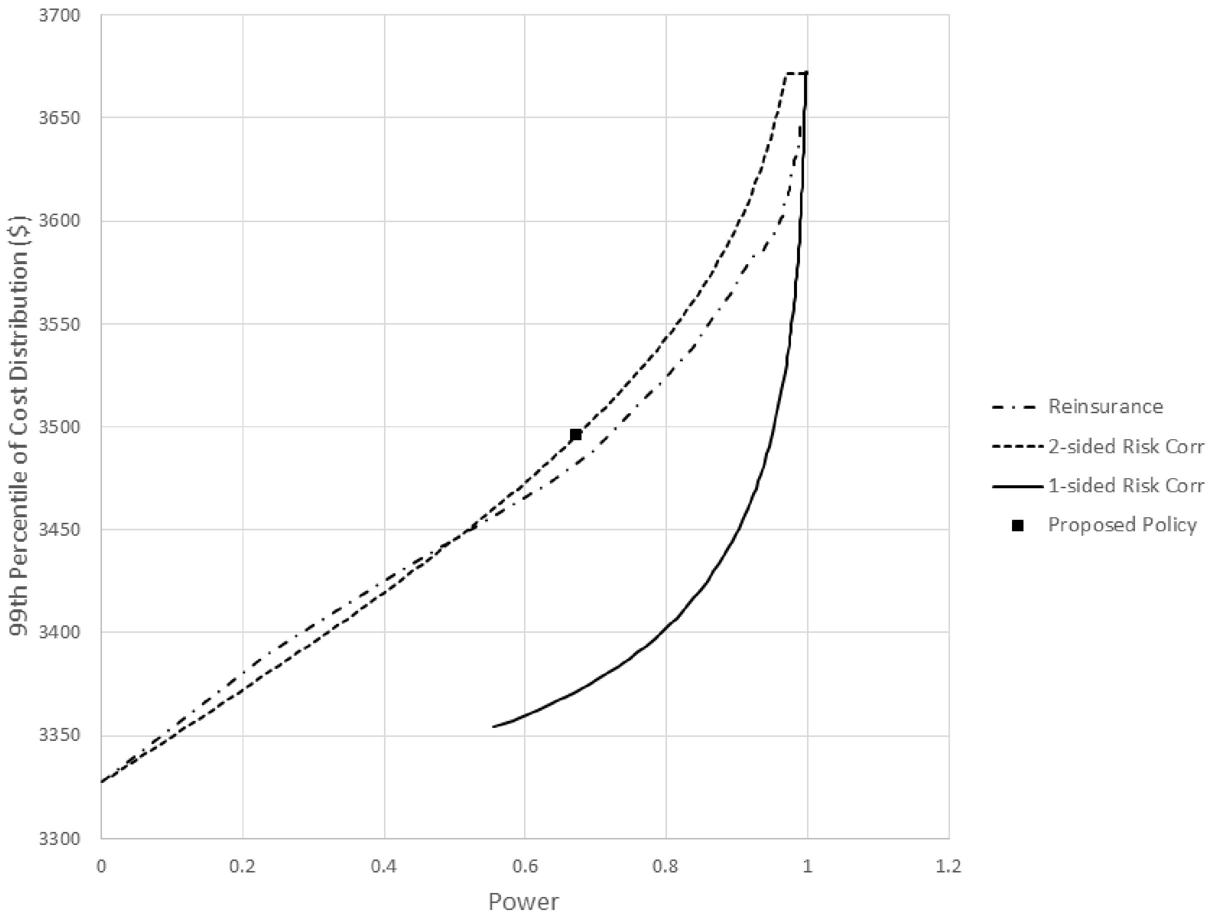
Notes: The figure shows the standard deviation of the cost distribution on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.

Figure 3: Power and 95th Percentile of Cost Distribtion with Reinsurance and Risk Corridors



Notes: The figure shows the 95th percentile of the cost distribution on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.

Figure 4: Power and 99th Percentile of Cost Distribution with Reinsurance and Risk Corridors



Notes: The figure shows the 99th percentile of the cost distribution on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.

Table 1: Summary Statistics of the Full Population

Values in table are means unless otherwise noted	N=76647
Demographics	
Age 0-18	0.16
Age 19-34	0.33
Age 35-44	0.19
Age 45-64	0.32
Male	0.51
Married	0.49
Race	
White, non-Hispanic	0.5
Black, non-Hispanic	0.14
Hispanic	0.28
Other	0.08
Education	
Less than high school	0.19
High school	0.29
Some college	0.15
College degree	0.25
Employment status	
Continuously employed	0.64
Continuously unemployed	0.11
Income	
Family income	$69,103.88
Medical	
Total annual expenditures	$3,103.48
Insurance Status	
Uninsured	0.46
Non-group	0.04
Expensive ESI	0.06
Self Employed	0.005
Medicaid	0.1
Small Group ESI	0.27
Health Status	
Excellent	0.32
Very good	0.32
Good	0.27
Fair	0.08
Poor	0.02

Notes: Statistics calculated for Marketplace-eligible population constructed from panels 9-14 of the MEPS. We select adult, non-elderly individuals in households earning at least 138% of FPL and children in households with income of at least 205% of FPL. We include households where an adult is ever uninsured, a holder of a non-group insurance policy, self-employed, employed by a small employer, or paying an out-of-pocket premium for their employer-sponsored health insurance (ESI) plan that is deemed to be unaffordable. If an individual meets the selection criteria in at least one of the two survey years, she is part of the sample. The dataset comprises 44,210 "Marketplace-eligible" individuals, 11,773 of whom have only one year of data and 32,437 of whom have two years of data, generating a total sample size of 76,647 person-years.

Table 2: Insurer Risk under Proposed Policies

Risk Measure	Base Case	Reinsurance Only	two-sided Risk Corridor Only	Reinsurance and two-sided Risk Corridor
Standard Deviation	$137.93	$101.38	$104.75	$85.40
95th Percentile of Cost Distn	$3,563.03	$3,493.41	$3,495.14	$3,460.33
99th Percentile of Cost Distn	$3,671.94	$3,565.71	$3,526.09	$3,496.47
Power	1	0.89	0.68	0.67

Notes: Each column represents a different set of policies and each row represents a moment of the insurer's cost distribution under those policies. The cost distribution in the base case is approximated by taking 10,000 draws of 5,000 individuals from the population of Marketplace-eligible individuals we create from MEPS data. The cost distributions under reinsurance, risk corridors, and both reinsurance and risk corridors are approximated by starting with the base case distribution and then calculating the reinsurance and risk corridor transfers and fees according to the parameters proposed for implementation in the Marketplaces.

Appendix: Results from simulations of a plan with 20,000 enrollees

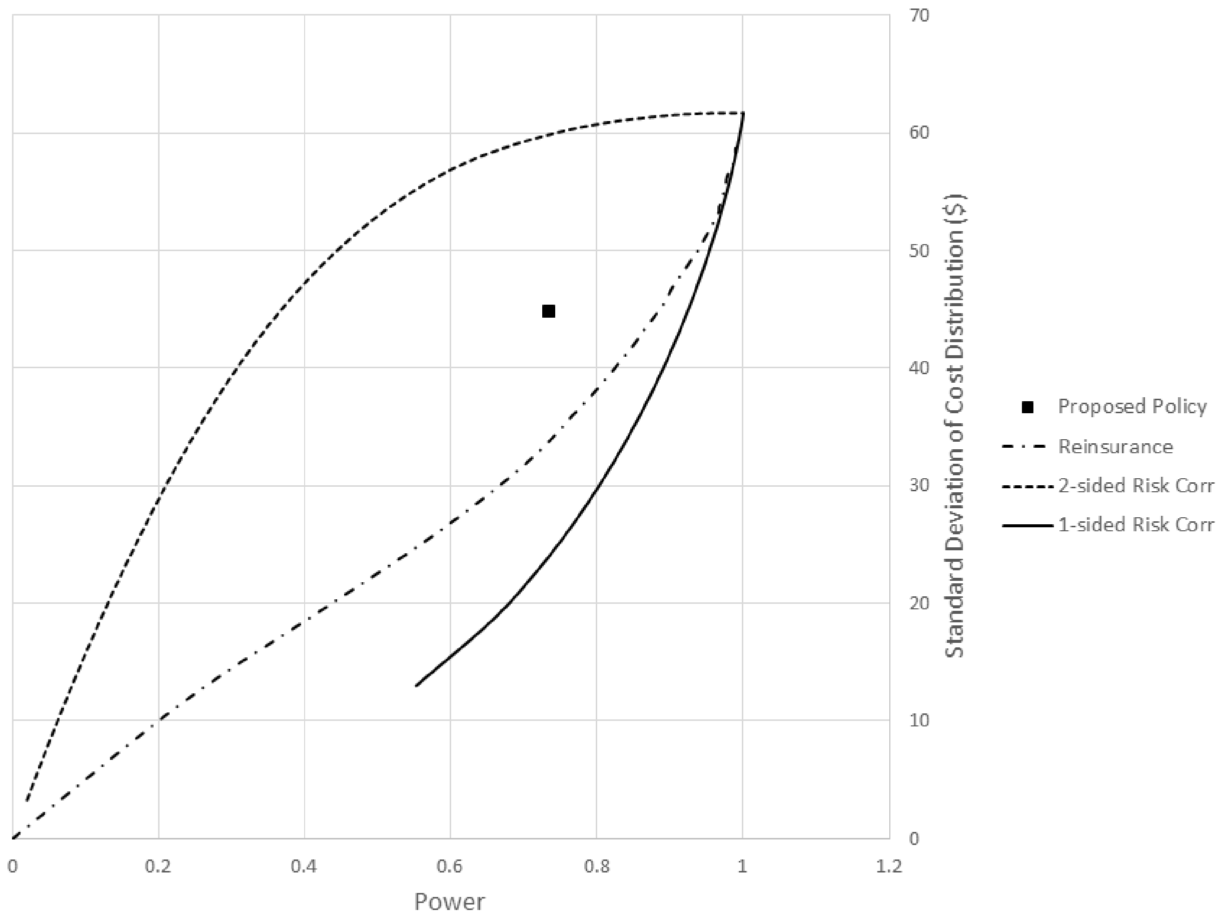
This Appendix presents results from simulations of a plan with 20,000 enrollees. constructed through 5,000 draws of 20,000 enrollees from the Marketplace-eligible sample. It is informative to study how the results differ by plan size for two reasons. First, insurer behavior with respect to a specific market or product may reflect the risk borne by the insurer across all products in all markets rather than the risk borne in one product in one market, depending on the structure of manager incentives. Second, by the law of large numbers the insurer's risk will decrease with the number of enrollees. This implies that the effect of the policies on insurer risk may be smaller because there is less uncertainty. The open question is whether the relative performance of reinsurance and risk corridors remains constant across plan sizes.

Figure A1 mimics Figure 2 in the main body of the text, with the only difference being that the results shown in Figure A1 are from a plan with 20,000 enrollees instead of 5,000. It is clear that when measuring risk with the standard deviation of the cost distribution, reinsurance and one-sided risk corridors dominate two-sided risk corridors. Both two-sided risk corridors and reinsurance can reduce the standard deviation to zero, but the smallest standard deviation one-sided risk corridors can achieve is approximately $12. This is due to the fact that while reinsurance and two-sided risk corridors affect both sides of the cost distribution, one-sided risk corridors only affect the right side. In the range of risk reduction that is feasible with one-sided risk corridors, one-sided risk corridors dominate reinsurance and two-sided risk corridors according to our measures. However, outside this range, reinsurance dominates the other policies according to the standard deviation of the cost distribution.

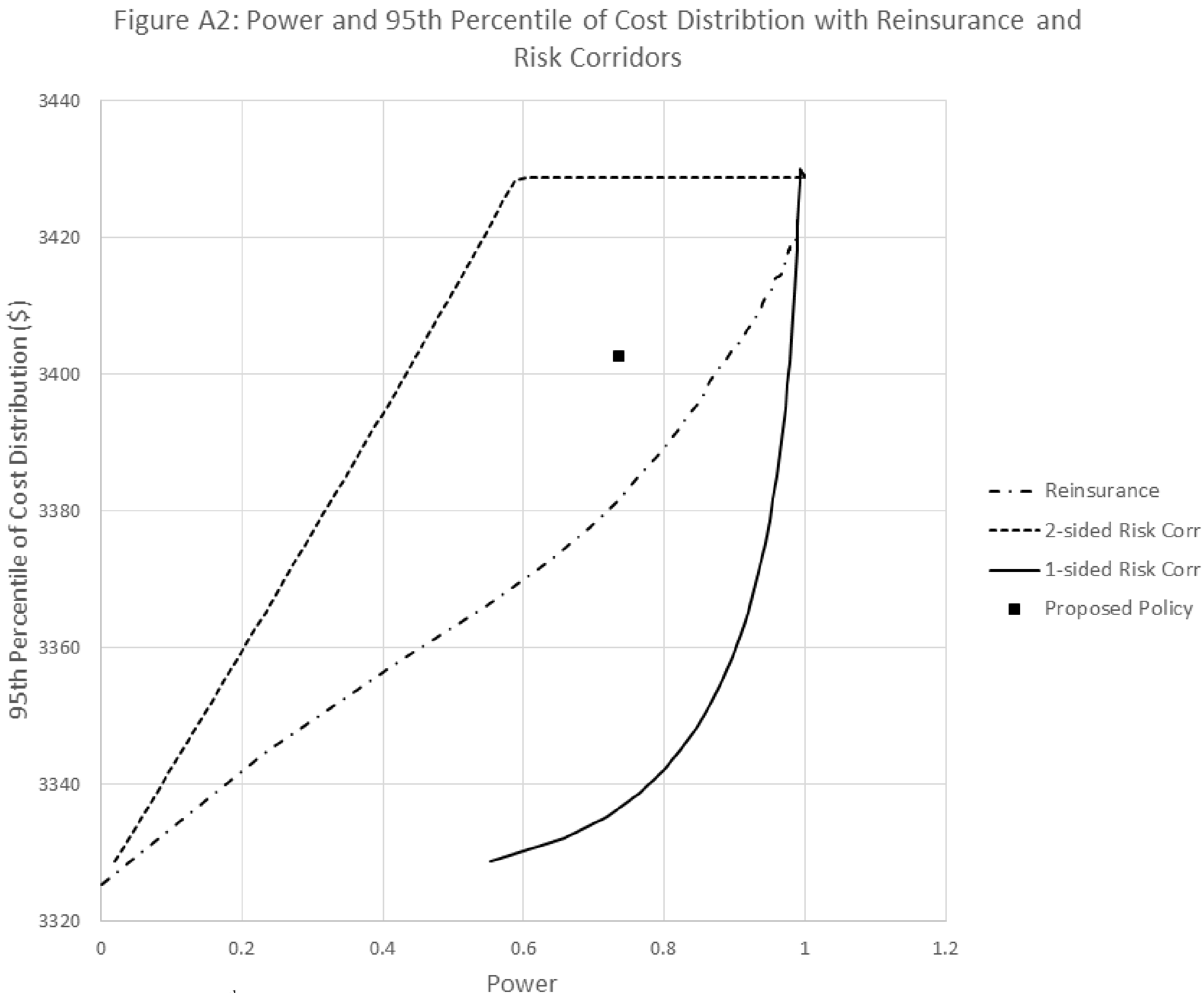
Figures A2 and A3 mimic Figures 3 and 4 in the main body of the text, presenting results on the trade-off between risk reduction and insurer incentives using the "value at risk" measure of insurer risk. Figure A2 uses the 95th percentile of the cost distribution and Figure A3 uses the 99th percentile. For any feasible level of risk reduction, one-sided risk corridors provide insurers with stronger incentives to restrain costs (i.e. higher power), implying that again one-sided risk corridors dominate two-sided risk corridors and reinsurance according to these measures of risk and insurer incentives.

Each figure also includes a black square representing the hybrid reinsurance/two-sided risk corridor policy being implemented in the ACA Marketplaces. For each measure of risk, a simple "full coverage after a deductible" one-sided risk corridor policy (or even a simple "full coverage after a deductible" reinsurance policy) dominates the hybrid Marketplace policy for plans with 20,000 enrollees.

Figure A1: Power and Standard Deviation of Cost Distribution with Reinsurance and Risk Corridors

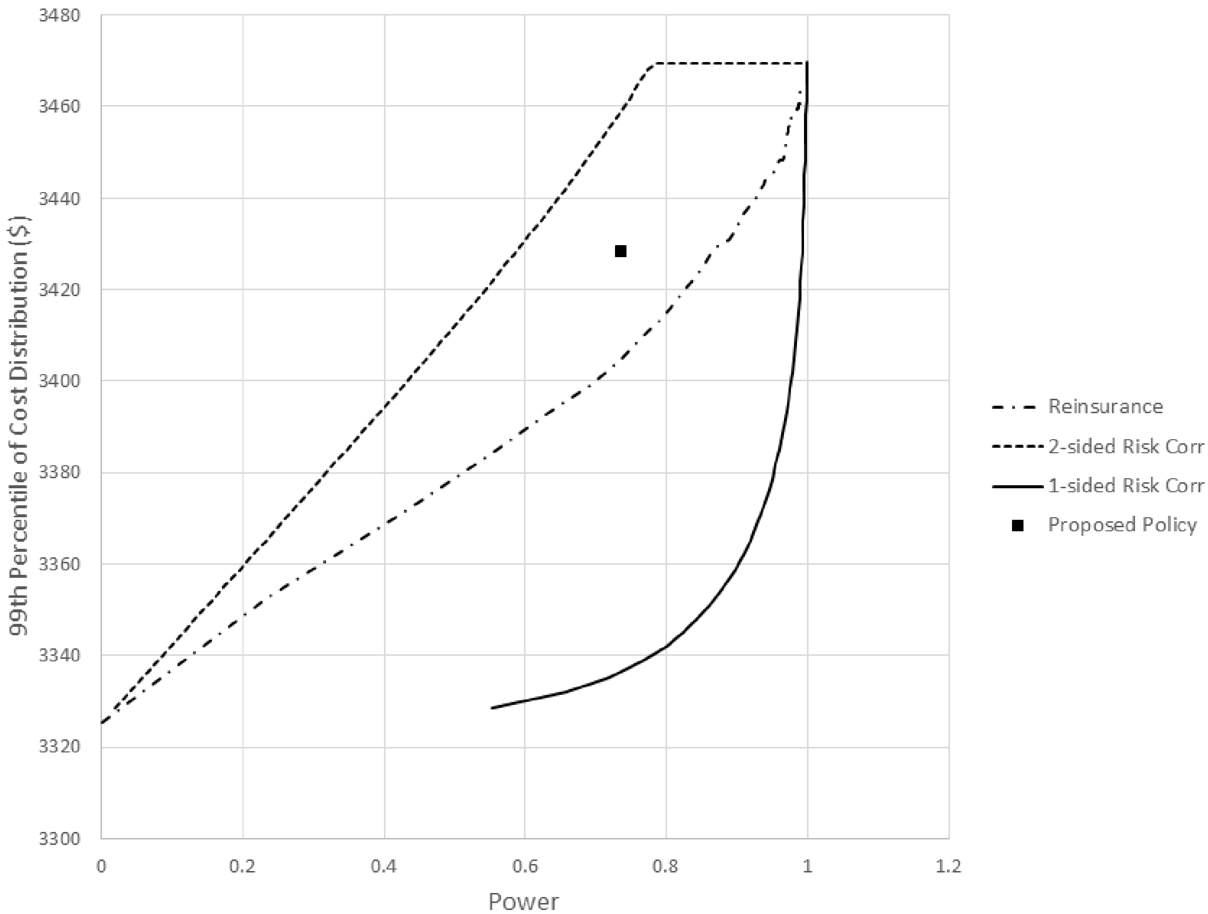


Notes: The figure shows the standard deviation of the cost distribution for a plan with 20,000 enrollees on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.



Notes: The figure shows the 95th percentile of the cost distribution for a plan with 20,000 enrollees on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.

Figure A3: Power and 99th Percentile of Cost Distribution with Reinsurance and Risk Corridors



Notes: The figure shows the 99th percentile of the cost distribution for a plan with 20,000 enrollees on the y-axis and simulated power on the y-axis. For any given level of power, the lines show the level of risk achieved by a reinsurance, or risk corridor policy generating that level of power. The joint distributions of power and risk shown in the figure are simulated using the insurer cost distribution constructed from MEPS data. For reinsurance, we simulate policies reimbursing plans for 100% of an individual's costs above some threshold ranging from $0 to $375,000. For risk corridors, we simulate policies reimbursing plans for all plan-level costs exceeding a fixed percentage of the mean of the cost distribution. We allow the percentage to range from 100.1-130%. For two-sided risk-corridors plans with low costs transfer money to plans with high costs. For one-sided risk corridors transfers are funded through a uniform per capita actuarially fair risk corridor premium.