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Michael Geruso
Thomas G. McGuire

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Cambridge, MA 02138
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## ABSTRACT

In many markets, including the new U.S. Exchanges, health insurance plans are paid by risk-adjusted capitation, in some markets combined with reinsurance and other payment mechanisms. This paper proposes three metrics for analyzing the insurer incentives embedded in these complex payment systems. We discuss fit, power and balance, each of which addresses a distinct market failure in health insurance. We implement these metrics in a study of Exchange payment systems with data similar to that used to develop the Exchange risk adjustment scheme and quantify the empirical tradeoffs among the metrics. We show that an essential tradeoff arises between the goals of limiting costs and limiting cream skimming because risk adjustment, which is aimed at discouraging cream-skimming, is in fact tied to costs. We find that a simple reinsurance system scores better on fit, power and balance than the risk adjustment scheme in use in the Exchanges.

Michael Geruso
University of Texas at Austin
Department of Economics
1 University Station C3100
Austin, TX 78712
and NBER
mike.geruso@austin.utexas.edu

Thomas G. McGuire
Department of Health Care Policy
Harvard Medical School
180 Longwood Avenue
Boston, MA 02115
and NBER
mcguire@hcp.med.harvard.edu

## 1. Introduction

Payments to private health plans in regulated insurance markets are complex, often mixing a array of mechanisms aimed at achieving the dual goals of constraining cost growth and limiting the distortions created by selection. When considered in isolation, features like prospective or concurrent risk adjustment, capitation, and reinsurance have clear theoretical links to addressing particular inefficiencies. However, these features are widely used as components of larger payment systems, and the net insurer incentives created by such combinations have been essentially unexplored, both theoretically and empirically. Given the prominence of these regulatory mechanisms in both private and publicly subsidized health insurance markets in the US and elsewhere, the issue is of tremendous practical importance. The lack of prior work assessing the *de facto* incentives generated by the mechanisms intended to control costs and mitigate adverse selection distortions in real-world payment systems is surprising, since cost control has attracted significant policy interest in recent years, and over the same period there has been a surge of empirical and theoretical work in economics on adverse selection in health insurance markets.[1]

We show that an essential tradeoff arises between the goals of limiting costs and limiting cream skimming because risk adjustment, which is aimed at discouraging cream-skimming, is in fact tied to costs. In practice, the conditions used to determine risk adjustment are established during provider-patient interactions in which a bill (claim) is generated. For example, under Medicare's private plan option called Medicare Advantage a single physician office visit at which a patient receives a new diagnosis of "diabetes without complications" changes a patient's relative risk score by 16.2 percent of the mean, resulting in an additional payment of approximately $1,500 annually from Medicare to the private health plan enrolling that individual. But the visit generating the diagnosis, and the follow-up events the visit triggers such as further diagnostic testing, are also components of cost to the plan, creating a link between payments a plan receives from risk adjustment and the plan's realized costs.

This paper proposes an empirical framework for evaluating the *de facto* insurer incentives embedded in the regulations and payment systems that govern health insurance markets. We then apply this to evaluate the ACA Exchanges, in which plans are paid by capitation with concurrent risk adjustment and reinsurance. We classify incentives for analyzing payment schemes along three dimensions that capture the main regulatory concerns in health insurance markets, including

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[1] See Chetty and Finkelstein (2013) for a comprehensive review.

containing adverse selection, controlling costs, and eliminating margins of distortion across different types of services. Specifically, we study what we refer to as the *fit*, *power* and *balance* of payment systems.

The notions of fit and power are established in the prior literature, though seldom have these characteristics been considered jointly. Fit refers to how well variation across enrollees in plan costs is explained by variation in payments, and has been closely tied to the evaluation of risk adjustment (e.g. Van de ven and Ellis 2000 and Breyer, Bundorf and Pauly 2012). In the risk adjustment literature, fit is often operationalized as an $R^2$ in a regression of costs on risk adjuster variables. We generalize the standard $R^2$ measure to include the effects of all features that link payments to realized costs, including reinsurance. Power is meant in the sense of the power of a contract (Laffont and Tirole 1993): it describes how the payer or regulator compensates expenditure by plans on the margin. The widespread adoption of capitation in private markets and public insurance systems in the 1980's and its continued use today is the clearest evidence of implicit interest in contract power in these markets. The most explicit consideration of power in a payment system in the prior literature was by McClellan (1997) who assessed the *de facto* utilization incentives in Medicare's Prospective Payment System, which paid hospitals for Medicare admissions on the basis of Diagnosis-Related Groups (DRGs). McClellan showed that in practice the Prospective Payment System included a large retrospective component, with approximately 55 cents of each dollar in hospital costs recovered in higher payments on average. In our terms, the power of the hospital DRG-PPS system was .45. Unlike our focus here, the implicit tension between fit and power was not considered by McClellan.

Our introduction of balance is original. Balance assesses the differences in power across various types of medical services. If medical events in one area of care impact insurance plan payment more than medical events in another area, the power of the payment system will be greater in the second area than in the first. We show that even if risk adjustment succeeds in removing the incentive for insurers to distort benefits to attract a particular set of enrollees, it can create new incentives to distort benefits conditional on a fixed set of enrollees.

The first main contribution of this paper is to quantify for the first time the *de facto* incentives embedded in payment schemes that feature capitation with risk adjustment and reinsurance. Traditionally, diagnostic risk adjustment has been viewed as fitting payments to expected costs without sacrificing this cost-control incentive, under the premise that risk adjustment compensates for patient characteristics rather than services provided (Pope et al., 2011). We argue here that characterizing the *de facto* properties of a capitation payment system is an empirical matter and depend crucially on the details, such as whether risk adjustment is prospective (based on diagnoses in the prior plan year) or concurrent (based on diagnoses in the current plan year). We describe how power and balance can be easily measured with simulation methods applied to claims data that trace out how variation in healthcare utilization maps to variation in payments in even complex payment systems.

Using two years of claims from the same database of insureds used to calibrate Exchange risk adjustment by the Department of Health and Human Services, we randomly eliminate healthcare events and measure the extent to which insurer payments and costs respond under various payment schemes. The Exchange payment system is particularly complex so we take it apart to assess the partial contribution of some of its key features, such as the decision to pay plans with a concurrent rather than a prospective risk adjustment formula.

We find that, consistent with the expressed intentions of the Exchange regulators, concurrent risk adjustment confers dramatically better fit than would prospective risk adjustment in this setting. Concurrent risk adjustment in isolation more than doubles the fit to .40 compared to prospective risk adjustment. However, we show that it does so at the cost of reducing power—that is, the incentive to constrain spending—dramatically. Further, our simulations reveal that both forms of risk adjustment feature significant imbalance. For example, the average power for inpatient services in the concurrent risk adjustment systems used in Exchanges is about .62, but power for the top ten major diagnostic categories ranges from .20 to .91, implying that the marginal reimbursement rate across these categories ranges from 80 cents on the dollar to 9 cents on the dollar. This is a margin of potential distortion that to our knowledge has been ignored in past treatments of risk adjustment.

The second main contribution of this paper is to challenge the conventional wisdom that risk adjustment should be the preferred mechanism for linking payments to expected costs without weakening insurer incentives to control costs. A few recent studies have pointed to potential problems with risk adjustment including favorable selection (Brown et al 2014, Newhouse et al. 2012) and manipulable coding (Geruso and Layton 2014; Kronick and Welch 2014), though such studies haven't evaluated the performance of risk adjustment relative to an alternative payment scheme. One of our most striking findings is that in terms of fit, power and balance, ACA-mandated reinsurance alone dominates ACA diagnosis-based risk adjustment. Specifically, when considered singly, the (temporary) reinsurance feature of plan payment in the Exchanges provides a similar fit, is more powerful, and is better balanced than the concurrent risk adjustment system slated for indefinite continued use in the Exchanges. This is in part due to the fact that reinsurance activates for only the small fraction of high-cost cases with the largest impact on fit, while retaining high-powered incentives throughout most of the spending distribution. This finding that a simple reinsurance scheme dominates ACA risk adjustment exposes the extent to which the incentives created by risk adjustment have been widely misunderstood. The results stand in stark contrast to the near universal preference for diagnostic risk adjustment over reinsurance in health systems in the US and abroad.

More broadly, our framework sheds new light on a fundamental tension in health plan payment between the dual goals of cost control and combatting selection, even though it does not equip us to measure total welfare associated with various payment system alternatives. In contrast to prior studies examining inefficiencies due to selection that have focused on an isolated distortion (e.g. cream-skimming in Frank, Glazer, and McGuire 2000 or price distortions in Einav, Finkelstein and Cullen 2012), quantifying welfare here is difficult because our notion of the relevant welfare margins is broader than what is usually examined in the literature. It includes for example, optimal spending in healthcare relative to other goods.[2] Our focus on the characteristics of fit, power, and balance—which relate to specific regulatory concerns—complements this prior literature and allows us to make progress on comparing payment systems without, for example, solving the intractable problem of determining optimal healthcare spending. Our framework shows how the use of concurrent risk adjustment in the Exchanges relative to the alternative prospective risk adjustment decreases power (weakening cost containment incentives) while simultaneously improving fit (better addressing cream-skimming incentives). Quantifying these effects is useful, even though the framework cannot evaluate how much a better fit is "worth" in terms of a sacrifice in power. We envision that tradeoff as being assessed by a regulator's objective function, which will vary across market settings. And as we show, the payment policy proposed for long-term use in Exchanges is dominated by another feasible alternative.

These findings are important for the continued reform of US health insurance markets, which increasingly follow models of managed competition. Our framework and quantitative results present a clear set of considerations and benchmarks for regulators and policymakers aiming to simultaneously address concerns about selection and cost control in markets for private plans in

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[2] Indeed, no study has simultaneously addressed selection inefficiencies and the optimal level of healthcare spending overall.

Medicare, Medicaid, and the Exchanges. Most importantly, we illuminate and quantify the empirical tradeoff between these concerns. Further, our simulation methodology is simple to adapt for regulatory agencies and researchers wishing to analyze insurer incentives in other payment systems.

The remainder of the paper proceeds as follows. Section 2 defines fit, power and balance, and develops the rationale for these measures as grades of a payment system. Section 3 describes our data and how we operationalize the payment schemes in the context of Exchanges. Results are in Section 4. Section 5 discusses the implications of our analysis for plan payment policy and research, and Section 6 contains some brief conclusions.

## 2. Fit, Power and Balance of a Payment System

This section develops the rationale and explicit definitions for our three measures of payment systems: fit, power and balance. Sections 2.1 and 2.2 begin by defining fit and power and then describing the tradeoff between the two. Section 2.3 extends the power analysis to more than one service by defining balance, and shows that a balanced system is (second) best.

### 2.1 Fit

*Fit* describes how well payments to plans track plans' costs. Fit has long been an object of interest among regulators and researchers because, conceptually, fit is tied to a payment scheme's ability to address adverse selection and cream skimming (Van de Ven and Ellis 2000). By matching payments to costs irrespective of health state, better fit mitigates incentives for insurers to cream-skim the healthiest, lowest-cost consumers among the insurance pool, perhaps by distorting the benefits package (Breyer, Bundorf and Pauly, 2012). Better fit also flattens the firm's perceived cost curve, reducing the Akerlof (1970) selection problem of feedback from average costs into prices that was highlighted in Einav, Finkelstein, and Cullen (2010). Nonetheless, there is no general analytic relationship that links fit to welfare.

An $R^2$ measure has been widely applied as a criterion for evaluating the fit of risk adjustment algorithms (Breyer, Bundorf and Pauly, 2012). For example, for the risk adjustment system used in the Exchanges, risk adjustment parameters were chosen as the coefficients maximizing the $R^2$ in a regression of costs on a hierarchical list of medical conditions. The Exchange risk adjustment scheme explains about 30% of the variance of costs (Department of Health and Human Services 2012). We follow the literature and regulatory interest in summarizing fit in an $R^2$ measure, though following Zhu et al. (2013) we adopt a metric that captures the $R^2$ of all aspects of the payment system, not merely the risk adjustment component.

Consider N individuals in a market indexed by i, i = 1,…,N. Cost for individual i is $x_i$, and the average cost in the population is $\bar{x}$. The payment system (which could be composed of diagnostic, demographic, and cost-related elements) leads to a payment of $p_i$ for person i. We define the *fit* of the payment system as:

$$\text{Fit} \equiv 1 - \frac{\sum_i (x_i - p_i)^2}{\sum_i (x_i - \bar{x})^2} \qquad (1)$$

The fit measure in (1), analogous to an $R^2$, is the portion of the variance in costs explained by the payment system. A capitation payment system that just returns the population mean spending as the payment for each person, $p_i = \bar{x}$, covers costs on average but explains none of the variance in cost and so would have a fit of zero. A plan would then have strong incentives to skimp on quality or coverage to deter demand from the sicker enrollees. A cost-based payment system in which $p_i = x_i$ explains all of the variance in cost and has a fit equal to one.

The generalization in (1) accommodates the evaluation of many types of payment mechanisms, including reinsurance, capitation with risk adjustment, and "mixed systems" which blend together capitation and cost-based reimbursement by setting payments equal to a weighted average of individual costs and population average costs. A mixed system is relatively simple to implement in practice and can be easily characterized in terms of power and balance. A mixed system therefore serves as a convenient and relevant standard against which to compare the performance of the more complex alternatives involving risk adjustment. Consider a 50/50 mixed system setting payment equal to the half the population average plus half the cost that the individual incurs. This generates $p_i = .5\bar{x} + .5x_i$. For this 50/50 mixed system, fit is .75, following Equation (1).[3] Intuitively, since deviations are squared in the fit measure, cutting the deviations exactly in half captures 75 percent of the variance in costs. Writing the mixed system in general form with a weight of $\lambda$ on the population mean cost and (1- $\lambda$) on the individual's realized cost, the fit of a mixed system is

$$\text{Fit}(\lambda) = 1 - \frac{\sum_i (x_i - \lambda\bar{x} - (1-\lambda)x_i)^2}{\sum_i (x_i - \bar{x})^2} = 1 - \lambda^2. \qquad (2)$$

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[3] $\text{Fit (50/50 mix)} = 1 - \frac{\sum_i (x_i - .5\bar{x} - .5x_i)^2}{\sum_i (x_i - \bar{x})^2} = 1 - \frac{\sum_i (.5x_i - .5\bar{x})^2}{\sum_i (x_i - \bar{x})^2} = .75.$

Thus, if a mixed payment system weights the population mean at .8 and the individual realized costs at .2, the payments explain 36% of the variance in health care costs.

The fit of payment systems combining risk adjustment and a mixed system can be calculated analytically if the $R^2$ of the risk adjustment algorithm is known. Suppose a risk adjustment system on its own has an $R^2$ equal to $R^2_{RA}$.[4] If the risk adjusted capitation payment, denoted $p_i^{RA}$, gets a weight $\lambda$ and a person's realized cost gets a weight $(1- \lambda)$ in the payment system, then fit is:

$$\text{Fit (RA, } \lambda) = 1 - \frac{\sum_i (x_i - \lambda p_i^{RA} - (1-\lambda) x_i)^2}{\sum_i (x_i - \bar{x})^2} = 1 - \frac{\lambda^2 \sum_i (x_i - p_i^{RA})^2}{\sum_i (x_i - \bar{x})^2} = 1 - \lambda^2 (1 - R^2_{RA}), \qquad (3)$$

where the latter equality follows from the definition of $R^2_{RA}$. For example, if the risk adjustment explains 10 percent of the variance and the population weight $\lambda$ is .50, the fit of the payment system is 1 - .25(.90) = 77.5 percent.

For more complex payments systems, such as when reinsurance combines with risk adjustment, fit will need to be evaluated empirically via Equation (1).

### 2.2 Power

We use the term *power* as it is used in contract theory, to describe the share of costs at the margin born by the health plan.[5] Power in health insurance contracts is tightly linked to the goal of cost control, as it describes the insurer's marginal incentive to limit healthcare spending. Insurers are in a position to materially affect healthcare spending--for example by limiting quantity via patient cost sharing and gatekeeping, by increasing the patient's shadow price of care in certain clinical areas via long waits or limited networks, and by lowering prices paid to providers via selective contracting.

In health insurance markets, contracts are generally less than full-powered; for example, in many settings, including the ACA Exchanges, insurers reinsure against large losses. Therefore, for insured individuals with spending above some threshold level of claims, there are weakened incentives for the insurer to limit claims. Further, as we show below, any risk adjustment system in health insurance which uses diagnoses linked to claims will have less than full power.[6] Power is

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[4] $R^2_{RA}$ is equal to the variance in costs explained by the risk adjustment payment $p_i^{RA}$, or: $1 - \frac{\sum_i (x_i - p_i^{RA})^2}{\sum_i (x_i - \bar{x})^2}$.

[5] Power is maximized with a fixed price contract and decreases as the price is tied to realized costs. See Laffont and Tirole (1993, p. 11).

[6] The temporary risk corridors in which the regulator shares gains and losses with Exchange plans beyond certain thresholds also reduce the power of ACA plan payments. Assessing the effect of risk corridors would require a different

therefore likely to vary considerably away from full (i.e., 1.0) in this setting, with potentially substantial impacts on plan incentives for healthcare spending.

If an insurer's payment $p_i$ is invariant to changes in realized costs $x_i$, as it would be in a plan paid by an age-gender only risk adjustment system, the power of the payment system would be at the maximum of 1.0. Conversely, in a cost-based system where payment tracked costs exactly, the power would be 0. Away from these polar cases of payment systems, the change in payment for a person with respect to a change in cost for a person could vary over people and vary over ranges of cost. For example, the first health care event in a diagnostic area will trigger higher payment, but subsequent ones may not. In general, the derivative, $dp_i/dx_i$, will depend on various factors, including levels of spending, and could differ for different categories of spending.

At the population level, characterizing a payment system as applied to a group of N enrollees, we define power ($\rho$) as:

$$\text{Power} \equiv \rho = 1 - \frac{1}{N}\sum_i \frac{dp_i}{dx_i}. \tag{4}$$

Power in (4) is an inverse measure of the change in payments for a marginal change in costs. In some cases, power can be determined from the design of the payment system itself. For a pure mixed system, power is simply $\lambda$, the weight put on the prospective portion of payment. For a reinsurance-only scheme, power could in principle be computed analytically as a function of the reinsurance threshold if the empirical distribution of enrollee claims costs were known. In general, however, (4) will vary over types and ranges of spending and will need to be assessed empirically. We explain how we use simulation methods to do so in Section 3.2 below.

With explicit definitions of fit and power we can begin to characterize the tradeoff between the two. The notion of a tradeoff between fit and power of a payment system has been recognized before (e.g., Newhouse, 1996) though we know of no attempt to assess the tradeoff empirically in the context of plan payment systems.

To illustrate the tradeoff, Figure 1 graphs the fit and power of several types of payment systems. Point A is a cost-based payment system, with fit equal to 1 and power equal to 0. Point B is a fully prospective system with no risk adjustment, which pays average cost and generates fit equal to 0 and power equal to 1. A simple mixed system combines the two, and from above we know that both fit and power can be expressed as a function of the weight $\lambda$ put on the realized costs. The

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form of simulation from what we conduct here. In particular we would have to make assumptions about the size of plans and adverse selection. See Zhu et al. (2014) who conduct such simulations.

combinations of fit and power achievable by a mixed system can be described by the solid curve in Figure 1, which traces Fit = 1 – $(\text{Power})^2$.

Note that the terms of the tradeoff in a mixed system are the same for any distribution of cost (the $x_i$); in other words, independent of the population under study. A feature of the tradeoff is that a small decrease in power away from power = 1, i.e., moving $\lambda$ away from 0, buys a good deal of fit. Lowering power from 1.00 to .9 (putting a 10% weight on costs, $x_i$) lifts fit from 0 to 19%. Similarly, a small decrease in fit from 1 yields a large increase in power. Lowering fit from 100% to 90% lifts power from 0 to .32.

Other points can be added to Figure 1 after empirical analysis: A capitation system that uses only age and gender could improve fit with no sacrifice in power at a point like C. A mixed system with weight $1-\lambda$ on costs and weight $\lambda$ on a hypothetical demographics-only risk adjustment system could produce the set of possibilities traced by the dotted line in Figure 1. Adding diagnoses from claims to the payment system would improve fit compared to point C but degrade power, and therefore lie above and to the left of C, in a region like D. Such points may or may not be outside the mixed system curves.

Before moving to balance, we note that more power in a payment system is not necessarily preferred. While a fully cost-based system ($\lambda$ = 1) gives too much incentive to supply care, a fully prospective system, asking the provider/plan to bear all costs at the margin ($\lambda$ = 0), may create the opposite problem and lead to underservice (Ellis and McGuire 1986; Newhouse 1996). Our goal in this paper is to quantify the power, fit, and balance of payment systems, not to find the constrained optimal combination, which will vary across markets, and is always relative to a regulator's objective function. Nonetheless, the focus in the current policy environment on more tightly constraining healthcare costs or cost growth suggests that the status quo power in the healthcare system lies below the desired level. Furthermore, optimal power on the supply side would depend on the demand-side incentives which aren't the object of our analysis.

### 2.3 Balance

Payment systems partly based on costs may create incentives to distort the distribution of resources devoted to particular types of services, one of the efficiency concerns that risk adjustment was introduced to address. A payment system with identical marginal reimbursement incentives across services is said to have *balance*. If costs across clinical areas are reimbursed differentially, then insurers may over-provide care in some areas and under-provide it in others. We propose to measure *imbalance* in the incentives in a payment system against the standard of equal marginal reimbursement incentives for all service areas.

From (4), we recognize that power could depend on the service, j:

$$\rho(j) = 1 - \frac{1}{N}\sum_i \frac{dp_i}{dx_{ji}} \tag{5}$$

For example, the power of the payment system could differ according to whether it was assessed with respect to spending on office-based care or hospital care or across various diagnostic categories. The relevant units j may be context-specific and could be chosen by the regulator.

We propose to measure imbalance by the weighted variance of power, which is the sum of squared deviations of power across services j, weighted by the share of spending on that service:

$$\text{Imbalance} \sim \sum_j \bar{S}_j(\rho(j) - \bar{\rho})^2 \tag{6}$$

Where $\bar{S}_j$ is the share of spending on service j in the population and $\bar{\rho}$ is the average power of the payment system. When the power is the same for every service area ($\rho(j) = \bar{\rho}$ for all j), imbalance in (6) equals zero.

We propose the imbalance measure (6) as a rough-and-ready intuitive welfare metric. In Appendix A, however, we provide the theoretical grounding for the weighted squared deviation measure of imbalance, showing that under certain conditions, (6) is proportional to the loss generated by imbalance. Proportionality to the share of spending in an area has an obvious rationale. And efficiency problems proportional to the square of a distortion are also a common feature of "Harberger triangle" type measures. Most importantly, it is not necessary to know the optimal power, $\bar{\rho}'$, to derive the result in (6).[7] Appendix A shows that the loss can be decomposed into a loss from the deviation of realized average power from the desired average power, plus the loss from the variation around this average. This implies that even if we do not know the desired power of the payment system overall we can still compute the loss from the variation around the realized average power. We return in the discussion below to the issue of whether other margins of distortion across clinical areas or types of service would affect the optimality of balanced incentives in a payment system.[8]

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[7] This would not be true if some services areas should be encouraged/discouraged differentially. For example, it might be desirable to encourage preventive care or discourage low-value care. While this is plausible, design of risk adjustment is not usually based on such considerations. If different optimal service-level specific $\rho(j)$s were known, then balance could in principal be redefined and measured as relative to the optimal $\rho'(j)$ for each j: $\sum_j \bar{S}_j(\rho(j) - \rho'(j))^2$.

[8] As before, it is possible to characterize some payment systems analytically. Notably, a mixed system has an average power of $\lambda$, and the power is the same for any category of spending. A mixed system is thus perfectly balanced. A reinsurance system can only be evaluated empirically, but will generally have some imbalance because spending for

## 3. Data and Empirical Framework

In order to empirically assess fit, power, and balance in payment systems, we use claims from large, self-insured plans to compare the actual costs of insuring enrollees to the simulated payments that would be made to plans under each payment system.

We focus on illuminating the incentives embedded in the concurrent risk adjustment and reinsurance regulations governing the ACA Exchanges. Concurrent risk adjustment links payments in a plan year to diagnoses entered in a patient's claims records during that same year. In the Exchanges it follows an algorithm designed by the department of Health and Human Services (HHS), which we discuss in detail below. Reinsurance in the ACA Exchanges is slated to end in 2016. Under Exchange reinsurance, insurers are required to pay reinsurance premiums and will receive a reimbursement of 80% of the individual claims that exceed an attachment point of $60,000 and fall below a cap of $250,000. This reinsurance operates separately from, and in addition to, the risk adjustment payment.[9]

### 3.1 Data

Our claims data come from the Truven Health Analytics MarketScan Commercial Claims and Encounters Database, which compiles health insurance claims from consumers insured by dozens of large employers across the US. Each claim lists the payment to the healthcare provider, and the portions of the bill paid by the insurer and by the consumer. Each claim also lists any associated procedures and diagnoses codes. Claims are linked to individuals, and individuals are linked across time. The same data source was used by US Department of Health and Human Services (HHS) for estimating the coefficients used in the risk adjustment model applied in the Exchanges.[10]

We take claims from 2008 and 2009—the most recent years available to us—and restrict attention to individuals aged 21 to 64, who are observed in both years.[11] The age range 21 to 64 corresponds to the definition of adult in the Exchanges. Because our simulations require observing the actual cost to the plan of each claim, we keep only those individuals for whom care was paid for

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different services will not fall equally among people for whom reinsurance is activated. An age-gender only capitation system has a uniform power of 1.0 and no loss from imbalance. Power in a risk adjusted system conditioning payments on medical events will vary by clinical area and feature some loss from imbalance.

[9] Below, we simulate reinsurance as applying to the very small fraction of spending above $250,000 as well in order to capture the practice of insurers purchasing supplemental reinsurance beyond the mandated ACA policy.

[10] The HHS estimation of risk adjustment weights used Truven MarketScan claims from 2010, and included individuals aged 0-64 with separate models estimated for children and adults. See Federal Register Vol. 78, No. 231 for full details of the HHS sample restrictions and estimation procedure.

[11] Data access was through the National Bureau of Economic Research.

on a non-capitated basis. From this sampling frame, we take a random sample of 2 million covered lives as our analysis and simulation sample, which we use to evaluate fit, power and balance.

Concurrent risk adjustment in the exchange system is based on a Hierarchical Condition Categories (HCC) model. HCCs are comprised of indicators for particular conditions, with each condition determined by the presence of a diagnosis or diagnoses in the patient's claims record.[12] The set of conditions that are represented in the HCCs were chosen by HHS. Risk adjustment coefficients, commonly called "risk adjustment weights," are generated from a regression of costs on HCCs at the individual level, and reflect the dollar value association between a health condition and expected costs. A person with several HCC conditions would have a risk score equal to the sum of the coefficients (weights) associated with each condition.

The HHS HCC risk adjustment weights are scaled so that a person with mean expected costs would generate a risk score of 1.0. Actual payment for a person is the product of the risk score and the average cost in the population. For example, an enrollee with a risk score of 2.0 generates a net plan payment that is twice as large as the payment for an enrollee of average expected cost. Plans are compensated by the regulator averaging risk scores within plans and then transferring a risk adjustment payment from plans with lower than average risk enrollees to plans with higher than average risk enrollees.

### 3.2 Counterfactual Risk Adjustment

Below, we consider a hypothetical prospective risk adjustment scheme as an alternative to the ACA's concurrent scheme. Prospective risk adjustment, in which prior period diagnoses determine current period risk scores is a more common alternative, used in Medicare Advantage, some state Medicaid programs, and public health systems across Europe. To evaluate this counterfactual we must first generate the parameters of the alternative hypothetical system (the prospective risk adjustment weights). For this we take advantage of the roughly 15 million individuals remaining in the sampling frame after drawing our analysis sample of 2 million. We use these out-of-sample observations to estimate the risk adjustment coefficients for this hypothetical payment mechanism, avoiding any overfitting problem caused by estimating and evaluating a payment system on the same sample.

We take two important steps to keep the counterfactual comparison to prospective risk adjustment consistent as possible with the actual Exchange system payment scheme. First, when estimating risk adjustment weights in the prospective model we use exactly the same set of

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[12] These conditions are referred to as "hierarchical" because the most severe condition within a clinical area determines the classification.

conditions (HCCs) chosen by HHS for the concurrent model. Given the set of reimbursable conditions, calculating the risk adjustment weights consists of a straightforward individual-level regression of the realized insurer costs in 2009 on a set of indicators corresponding to the HCCs in 2008. This calculation is standard with little room for discretion.[13] Second, in order to fairly compare the prospective and concurrent models, we re-estimate the weights for the concurrent model (2009 costs on 2009 conditions) on the same 15 million person sample used to estimate prospective weights, in all cases using the same mapping of diagnoses to HCCs defined by HHS. For consistency when comparing the two regimes, we use our estimated parameters for the concurrent system, rather than those dictated by HHS. Nonetheless, we show below that our main results are not sensitive to using the concurrent risk adjustment weights as estimated by HHS in place of those we estimate ourselves.

Further details about the risk adjustment system along with our empirical estimates of the parameters are reported in Appendix B. In all cases, the dependent variable in our risk adjustment regression is the total payments (insurer plus patient) in claims to service providers, a construction that removes any mechanical relationship between differences in cost sharing across plans (impacting net insurer costs) and sorting of different health types to different plans.[14]

### 3.3 Measuring Fit, Power, and Balance

Applying the definition in Section 2, we measure fit of the payment system as the $R^2$ from a regression of payments to plans on plan costs at the person level.[15] The cost variable is the total cost of the claims filed by the person, and the payment is the net payment, inclusive of risk adjustment and reinsurance premiums and payouts. Reinsurance payouts are determined to the formula described above applied to the simulated sample of claims, and reinsurance premiums are simply the actuarially fair premium implied by the average reinsurance payout in the 100% sample.

Unlike fit, which is intended to describe how payments track costs in the cross-section and is conceptually aligned with a cross-sectional regression, power involves a different conceptual and therefore empirical exercise. Since power is related to how reimbursements change at the margin

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[13] HHS attempts to set the risk adjustment coefficients so that the mean risk score in the population is approximately one, and final payments are based on a re-normed relative risk score for which the mean is exactly one. We follow the same procedure, re-norming all risk scores by the average risk score, so that the average risk score in our sample is equal to one.

[14] Restricting analysis to only the insurer-paid portion of claims would more closely align with the HHS process for estimating weights, but is less transparent and the makes little difference to results. HHS estimated separate models for plans with different degrees of coverage, the metal levels in the Exchanges. We are estimating a single model so do not have to be concerned with different plan shares of covered costs.

[15] In the case of a pure capitated, risk-adjusted payment scheme, this $R^2$ would exactly equal the $R^2$ from the regression used to estimate the risk adjustment weights if both regressions were estimated over the same population.

with utilization costs, we perform a simulation exercise that corresponds to a thought experiment of exogenously reducing utilization in order to trace the resulting change in payment for individual enrollees ($dp_i/dx_i$ in Equation 4). We ask, for example: If a plan succeeds in randomly reducing outpatient medical events by 10%, by how much does the payment for that enrollee change? And, how does this average out over an entire population of enrollees?[16]

We simulate changes in utilization by deleting, for our fixed population of enrollees, a random sample of the observed medical events. We define a medical event separately for outpatient and inpatient services, which both makes sense clinically and allows us to characterize power differently for these two major sectors of care. We define an outpatient event as all outpatient services during a single day and randomly eliminate all services that correspond to a particular patient-day pair. We define an inpatient event as a hospital stay, and we randomly eliminate hospital stays.[17] Thus, the variation used to measure power in this simulation is generated by reducing events within the medical histories of individual enrollees. Random deletion disregards the ease with which a plan might reduce the associated utilization, but is meant to characterize the incentives to do so imbedded in the payment system.[18] In other words, our measure of power focuses only on the particular object of interest here: the impact of the *payment system* parameters on incentives for insurer action. Of course, consumer preferences and various frictions dictated by the healthcare system will also play important roles.

To simulate reduced utilization we randomly sample without replacement medical events as defined above from individuals in our baseline sample of 2M adults. We remove 10% of events,[19] repeating the simulation five times and reporting mean payment and mean cost for the insured sample.[20] Each event removed decreases the plan's costs by the dollar amount of the claims associated with the event. Each event removed also affects the risk score with some probability

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[17] The obvious alternative to this approach would be to randomly eliminate "claims" from the MarketScan data. We view this alternative as less conceptually clear. An inpatient stay typically involves ten claims or more. One of these will be the large room and board claim for the stay itself, and this will be accompanied by claims for lab tests and other procedures associated with the stay. The thought experiment of eliminating the room and board charge but not the ancillary services made little sense. Eliminating one of the many minor claims associated with a hospital stay would by definition have no effect on risk adjustment because the diagnoses associated with the stay would be on the room and board charge. Analogous issues arise on the outpatient side.

[18] In practice, plans would choose the level of service provision weighing these payment incentives against competitive pressures and would also take into account the relative costliness of reducing utilization, for example, via more stringent gatekeeping.

[19] We also study the effect of removing smaller (5%) and larger (15%, 20%) share of events and report the results below. Power is essentially constant over this range.

[20] In practice with our sample of 2 million individuals, five repetitions yields very precise estimates.

because the diagnoses on the claims associated with the event are also removed. Claims pivotal in establishing a diagnosis defining an HCC have a direct effect on payment. Claims containing no new information used in risk adjustment, for example, claims associated with the second visit to a doctor during a year for the same condition, have no effect on the risk adjustment score. If a person's spending is in the range of reinsurance, removing an event will reduce payments for that person even if the risk score does not change.

For the final step of calculating power, for each individual we generate a counterfactual relative risk score based on diagnoses listed in the claims retained, and scale this score by the average cost in the original population.[21] We also take into account any change in reinsurance payments, evaluated at the simulated level of patient utilization, to calculate a new simulated payment for the individual. We then directly apply Equation (4) to summarize power for the entire population, substituting discrete changes for derivatives.

Finally, when evaluating the prospective risk adjustment payment system, we account for the fact that payments only impact utilization with a one-year lag and only for enrollees who remain in the same plan in the year after the diagnoses are recorded. Otherwise, a different insurer bears the payment response to a reduction in utilization. Exchanges are too new to have data on turnover, but recent research on non-group health insurance markets in the years 2008-2011 just preceding the ACA finds very high turnover rates (Sommers, 2014). In our Exchange simulations, we characterize two cases, assuming 100% and then 50% of persons enrolled in a plan in one year stay in that plan the next.[22] This parameter could be made more precise when applying our framework to a setting like Medicare Advantage, where the retention of elderly beneficiaries in plans year-to-year has been well-measured.[23] Here, we simply report results over a range of possibilities.

To characterize balance, we build on the power simulations, but divide events according to their primary diagnosis across the 25 Major Diagnostic Categories (MDCs), which are broad clinical groupings based on the five-digit ICD9 codes used in claims. For the 10 MDCs associated with the highest total dollar value of payments in our sample, plus the MDC for mental disorders, we replicate the simulation procedure we used to estimate power, but apply the sampling only to events

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[21] Scaling risk scores by the original population average costs corresponds to the experiment of perturbing utilization for a single individual or for a small plan that does not affect the regulator's normalization of the population-level risk scoring parameters.

[22] Sommers (2014) found somewhat higher turnover rates, on average 58%. We assume in effect that turnover will be reduced slightly in the Exchanges.

[23] In Medicare Advantage, turnover can occur because of plan exit as well as individual disenrollment. For plans remaining year-to-year, reenrollment rates are 90 percent or higher among the 65+ population. (Newhouse and McGuire, 2014).

associated with the MDC of interest. To illustrate, for MDC 5 (Diseases and Disorders of Circulatory System), we randomly remove 10% of events associated with that MDC and recalculate all risk scores. We also calculate the new cost of insuring the individual, and finally determine reinsurance payments. This yields a category-specific power. We show power for each clinical area and summarize balance by assessing squared deviations of power across categories from the system-level power, as called for in Equation (6).

## 4. Results

### 4.1 Fit Results

Column (1) of Table 1 grades payment systems according to fit.[24] We consider several versions of the ACA payment system. The first row, which includes only concurrent risk adjustment, corresponds to the payment system planned for the Exchanges for 2017 and beyond. The second row corresponds to a hypothetical Exchange payment system that included only the temporary reinsurance feature of the Exchange payment scheme. From 2014 to 2016, a transitional reinsurance program in the individual market will compensate plans for covering individuals with realized costs above an attachment point as described in Section 3. Row (3) corresponds to actual policy for 2014-2016, including both concurrent risk adjustment and reinsurance.

Concurrent risk adjustment in Row (1), nearly unique to ACA Exchanges, achieves a fit of 0.40, substantially higher than what is typically achieved under prospective risk adjustment.[25] Fit under reinsurance alone reported in Row (2) is remarkably high. This is intentional -- or at least implicit in the goal of shielding insurers from financial risk in the early years of the Exchanges. Even though reinsurance activates for only about 1% of individuals in our simulations, more than half of the variance in insurer costs is eliminated by reinsurance. In contrast, hypothetical prospective risk adjustment in Row (4) yields a fit of 0.11, similar to estimates of fit in other prospectively adjusted payment systems, such as Medicare Advantage. Adding reinsurance in Row (5) closes the gap between the concurrent and prospective risk adjustment payment schemes.

Fit under the 2014-2016 ACA scheme that includes concurrent risk adjustment and reinsurance in Row (3) achieves the highest fit of the options considered. This is not surprising. What is surprising is the small incremental contribution (.03) of concurrent risk adjustment when

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[24] Simulation results using the HHS weights in place of those we estimate are provided in Appendix C. All results are closely consistent.

[25] This compares to the 0.29-0.36 fit reported by regulators in Federal Register Vol. 78, No. 231.

added to ACA reinsurance. Also in contrast to the conventional wisdom, reinsurance with prospective risk adjustment (Row (5)) fits nearly as well as reinsurance with concurrent risk adjustment.[26]

## 4.2 Power Results

With regard to power, columns (2) and (3) in Table 1 characterize the power for inpatient and outpatient events for each of the five payment systems. Table 1 reports power for subtracting 10% of medical events at random in a simulation. Results for higher and lower shares of events deleted differed very little, implying that power of the payment systems was uniform over the range of 5-20% of events deleted.[27] Consistent with our discussion above about the *de facto* linking of expected and realized costs via healthcare events, power for concurrent risk adjustment shown in the first row deviates considerably away from 1.0. The .62 in the first row and second column means that for each dollar of cost removed when 10% of inpatient events are eliminated, payment falls on average by $0.38. The power of concurrent risk adjustment is greater for outpatient care, at .77, implying that the diagnoses lost as outpatient events are removed are less likely to be unique, i.e., appearing in other medical events, and thus having a smaller average effect on risk-adjusted payments.

Row (2) shows power for reinsurance only. Payments fall with reinsurance for medical events for persons whose total costs exceed the reinsurance threshold of $60,000. Persons with an inpatient event are more likely to be above this threshold so the power reduction from 1.0 is naturally greater for inpatient than for outpatient.

Combining concurrent risk adjustment and reinsurance degrades power considerably, as shown in Row (3). Looking first at inpatient, the power loss from concurrent risk adjustment of .38 plus the power loss from reinsurance of .28 sum to the power loss from their combination (1-.34 =) .66, implying that the margins on which these two payment features are reducing payments as events are removed are essentially independent. This "adding up" of power loss is also approximately true for events on the outpatient side where the power losses in the first two rows just sum to the power loss in the third row. An important takeaway emerges in comparing Rows (2) and (3): The fit gain of adding concurrent risk adjustment to reinsurance is small, but the power loss is considerable.

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[26] Note that the retention assumption is not important for the fit column. To study the fit of prospective risk adjustment we only need to observe the person in the previous year, irrespective of what plan they were in. The retention assumption matters only for power.

[27] The power for any of the systems studied for both settings of care differed by at most .01 across the range studied, 5% to 20%. Differences this small are not economically meaningful and are probably due to some randomness in the drawing of events.

Rows (4) through (7) show power for counterfactual prospective risk adjustment with and without reinsurance. Comparing Row (1) to (4) we see the unsurprising result that the power of prospective risk adjustment exceeds that of concurrent risk adjustment. This is because the diagnoses from the dropped events from the previous year predict current cost less well than diagnoses from similar events drawn from the current year. Appendix B reports the risk adjustment model estimates for concurrent and prospective models and confirms this observation. Dropping an HCC designation has a bigger impact in the concurrent than the prospective model as indicated by the generally larger estimated regression coefficients in the concurrent model.[28] Power of prospective risk adjustment with reinsurance, assuming 100% retention is also higher than with concurrent risk adjustment and reinsurance (compare Rows (5) and (3)).

Lower, more realistic retention rates further elevate power of prospective risk adjustment by disconnecting plan spending in year 1 (when events are used to determine risk scores) from that plan's revenues in year 2 for those members not continuing with the plan.[29] In the case of prospective risk adjustment and no reinsurance (Row (6)), for the 50% of the population not retained, the power of the payment system is 1.0. Power with prospective risk adjustment and partial retention is a weighted average of the power for the share retained from Row (4) and 1.0 for the share not retained. We use this to figure the power estimates of .96 for inpatient and .92 for outpatient in Row (6).

Reinsurance effects on power are not affected by retention rates since reinsurance is based on current year spending and so reinsurance works the same whether or not a person was in the plan the previous year. We approximate the power of prospective risk adjustment with reinsurance and 50% retention by assuming the power gain observed between Rows (4) and (6) would be the

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[28] Note that for prospective risk adjustment power is lower for outpatient events than inpatient events, the opposite of the pattern for concurrent risk adjustment shown in Row (1). This implies that at the margin of 10% events removed, the diagnoses coming from the outpatient side in a prospective system are more predictive of next year's spending than are the diagnoses coming from inpatient events. This finding is sensible if diagnoses recorded in outpatient events are more likely to capture chronic, persistent conditions, whereas diagnoses recorded on inpatient events are more skewed to acute medical events that may be less predictive of future costs. Compared to reinsurance alone, prospective risk adjustment alone has similar power for outpatient events, but higher power for inpatient events. The tradeoff is that fit is significantly sacrificed under prospective risk adjustment.

[29] The fit numbers do not need to be adjusted for retention if we assume an Exchange has data on people as they change plans and can use the overall Exchange data base for purposes of risk adjustment. A refinement on this approach would be to do something like what Medicare does for persons just becoming eligible at age 65, and use only demographics as risk adjusters in the first year of MA plan payment. In this case the retained share could be paid by the full risk adjustment system and the share not retained would be paid by the stripped-down formula.

same as between Rows (5) and (7).[30] This is reasonable in light of the independent margins on which risk adjustment and reinsurance largely appear to be operating upon. Clearly, reinsurance reduces power much more than does prospective risk adjustment.

### 4.3 Balance Results

We report results on balance in Table 2 for the same payment systems studied in Table 1. We list the 10 Major Diagnostic Categories (MDCs) associated with the largest total claims, as well as the MDC for Mental Health (MDC 19). We added the mental health category because it has been found previously to be subject to incentives to be underprovided in capitation-based managed care plans in both Medicare and Exchange payment systems.[31] Other diagnostic areas with similar characteristics are already included in the "top-ten" list. We chose MDCs for convenience with the purpose of highlighting the heterogeneity in how costs across different clinical areas are differentially reimbursed on the margin. One could evaluate balance by applying our Equation (5) across finer diagnostic categories; across places of service; or across primary, secondary, and tertiary care.

Table 2 contains the power estimate for inpatient and outpatient services for each MDC, as well as the summary measure for imbalance from (6). Each entry in Table 2 is the result of a separate simulation. For example, for inpatient care associated with MDC 8 (Musculoskeletal System and Connective Tissue) under concurrent risk adjustment (in the upper left of the table), .91 is the average over simulations in which 10% of the inpatient admissions with MDC 8 are removed at random. Payments in this category are reduced by 0.9% on average, yielding a power estimate of 1 – .009/.10 = .91.

Row (1) corresponds to concurrent risk adjustment. Comparison across clinical areas reveals significant heterogeneity in the power of reimbursement incentives. Under concurrent risk adjustment, the category with the lowest power (Respiratory Systems; outpatient) reimburses insurers 88 cents on the dollar of their costs, whereas the category with the highest power (Musculosketal Systems; inpatient) pays insurers just 9 cents on the dollar. The balance criterion introduced above indicates that the marginal incentives to provide care should be equalized across clinical areas. For the concurrent risk adjustment-only payment scheme, this implies the optimal power within each MDC is equal to the overall average, which is 0.62 for inpatient and 0.77 for outpatient in Table 1, though even this inpatient/outpatient disparity is itself a margin of balance

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[30] For inpatient power in Row (7), we add back the (.96-.91) difference and for outpatient power we add back the (.92-.85) to get power of .68 and .79 respectively for Row (7) with 50% retention.

[31] Results for Exchanges are described in McGuire et al. (2014). Results for Medicare are in Ellis and McGuire (2007). Both papers contain a review and references to related literature.

distortion.[32] The summary measure of imbalance across clinical areas from Equation (6) is shown in the last columns of Table 2.

What leads to some conditions being reimbursed at a higher rate than others on the margin under risk adjustment? Conceptually, the marginal reimbursement of a claim is a function of two factors. First is the probability that a claim is pivotal in establishing a diagnosis—conditions generating many individual claims with identical diagnoses tend to be associated with higher power. Second is the relative generosity with which a diagnosis is reimbursed in relation to the cost of the condition. The estimated coefficient in a risk adjustment model picks up the additional total costs associated with the appearance of a diagnosis, not only the direct cost of actually treating that condition. When we eliminate an event, we lose the direct costs of treatment. How much reimbursement is affected depends on how predictive a particular condition is for total costs.

With reinsurance the power reduction from 1.0 for services in each clinical area is roughly proportional to the likelihood that the person with the medical event has annual spending over the cut-point (if not reinsurance is not activated) times the share of spending covered by reinsurance (here 80%). Results for reinsurance alone are reported in Row (2). Under reinsurance, clinical areas that tend to be more frequently experienced by more expensive enrollees are the ones with greater power loss.[33] For example MDC 5, Circulatory System, is a category with low power under reinsurance because an expense in this MDC category is more highly correlated with the probability of individual spending exceeding the reinsurance threshold. In contrast MDC 14, Pregnancy and Childbirth, has very high power under reinsurance (but not concurrent risk adjustment) because pregnancy, despite being a strong predictor of costs below the reinsurance threshold, isn't associated with high right-tail spending by individuals.

At the bottom right of the table, the summary measure of imbalance shows that for inpatient events, the loss under concurrent risk adjustment alone is about 3 times as large as under reinsurance alone. For outpatient events, the loss from imbalance is 5 times as large under concurrent risk

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[32] We also note that MDCs are a natural unit of division for analyzing balance, but finer levels of aggregation—for example, further breaking up the circulatory system category into claims associated with hypertension versus acute myocardial infarction—would necessarily reveal even further imbalance *within* each MDC.

[33] This is an attractive feature of reinsurance, implying that illnesses associated with high-cost enrollees are reimbursed more generally on the margin. This acts against the plan's incentive to skimp on services for these illnesses to avoid these enrollees. The measures in this paper do not credit this feature of reinsurance.

adjustment. Row (3) shows that combining concurrent risk adjustment and reinsurance, as is done in the Exchanges from 2014 to 2016, worsens imbalance compared to either mechanism separately.[34]

Prospective risk adjustment, a standard alternative that we consider in Rows (4) and (5), represents a middle case. Compared to reinsurance alone, balance under prospective risk adjustment alone (Column 4) is worse for outpatient events, but better for inpatient events. Rows (4) and (5) calculate power for each clinical area assuming 100% retention. Power results for less than 100% retention could be figured as in Table 1 for power overall.

### 4.3 Summary of Tradeoffs

To visually summarize the many results in Tables 1 and 2, Figure 2 plots the three "grades" for each payment system, with power along the horizontal axis and fit along the vertical axis. Balance is represented by the diameter of the circle around each marker, which is proportional to the weighted variance measure in (6). A wider circle indicates a larger loss from imbalance—our attempt to represent the 3 dimensions on the page. The mixed system curve, which pays a lump sum plus a fixed fraction of each healthcare dollar spent by the insurer, is plotted as a solid line with the parameter $\lambda$ from Equation (2) ranging from zero to one. The mixed system has perfect balance by construction.

Focusing first on inpatient events in the left panel of Figure 2, the most striking results are for concurrent risk adjustment only and concurrent risk adjustment with reinsurance. These represent, respectively, the Exchange payment policies planned for 2017 and beyond and in place for 2014-2016. Not only are these payment policies dominated in terms of fit, power and balance by other feasible policies, they are also dominated by a simple mixed system that reimburses insurers a fixed fraction of each claims cost, as they fall inside the solid curve. For outpatient events in the right panel, the concurrent risk adjustment policies also fare poorly. They have the worst balance and power of any scheme, and only marginally better fit than reinsurance alone. In sum, the chosen payment scheme for the Exchanges is a dominated regulatory choice along these measures. This finding is significant and runs counter to the common intuition that risk adjustment is the best way to achieve fit without reimbursing actual realized costs on the margin.

Prospective risk adjustment alone sits on the envelope of the mixed system curve in the lower right of both panels, and unlike concurrent risk adjustment, is not dominated by reinsurance alone. It is characterized by high power, low fit, and good balance. Nonetheless, a mixed system

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[34] For MDC 4, power actually becomes negative when concurrent risk adjustment is combined with reinsurance, indicating that insurers are reimbursed more than dollar-for-dollar for consumer utilization in this category.

with a low weight of about .1 on realized costs beats prospective risk adjustment in terms of fit, approximately matches it in power, and dominates it in terms of balance. Adding reinsurance to prospective risk adjustment yields a payment system that grades similarly (but with slightly worse power and balance) to reinsurance alone.

In sum, the non-dominated options among the payment schemes assessed here are prospective risk adjustment alone and reinsurance alone. The choice between the two should hinge on whether cost control or information asymmetries are the problems the regulator considers most important. An additional consideration may be the relative regulatory simplicity of a reinsurance program.

Traditional treatments of risk adjustment in the literature have ignored balance, and have either implicitly or explicitly assumed away what we call the power incentive. However, Figure 2 shows that the *de facto* power incentive, as well as imbalance across services, is a non-trivial concern in risk adjustment, and in particular in concurrent adjustment. To put the size of the power problem in context, consider that concurrent risk adjustment yields a fit of .4 and power of .62, but a mixed system that simply pays insurers a fixed fraction for each enrollee dollar of healthcare utilization would achieve a power of .77 with the fit "set" to .4. In other words, concurrent risk adjustment—which is aimed at reimbursing expected, not realized costs—reimburses insurers more generously on the margin of realized costs than a policy explicitly aimed at reimbursing insurers on this margin. This is the principle reason we argue that the *de facto* insurer incentives involved in risk adjustment have been misunderstood.

## 5. Discussion

Our most significant finding is that concurrent risk adjustment, the permanent feature of ACA Exchange plan payment, fares poorly in relation to reinsurance, or even a simple mixed system, on all three performance metrics. Years of empirical research have focused on improving the statistical fit of prospective risk adjustment. Fit is even higher when, as in Exchanges, the risk adjustment is implemented concurrently. Nonetheless, the temporary reinsurance feature of Exchanges alone has much higher fit than the concurrent risk adjustment alone. Furthermore, concurrent risk adjustment contributed little incrementally to fit in when added on top of reinsurance.

Turning to power, diagnostic risk adjustment systems are conditioned on health care events and therefore linked to realized costs. This is true even of prospective risk adjustment, which creates no direct tie between current period utilization and an enrollee's risk score, as long as there is at least partial retention of enrollees in the same plan across years. Here we encounter another surprising result. Exchange reinsurance dilutes power on average less than concurrent risk adjustment. Exchange reinsurance also performs better than concurrent risk adjustment on our third measure of performance, the balance of incentives across clinical areas.

One reason why reinsurance may receive a better grading along power, fit, and balance than risk adjustment is that a large fraction of healthcare spending is generated by a small fraction of enrollees. Reinsurance activates in the upper tail of spending by design, while risk adjustment tends to systematically underpredict for persons with high expected costs (Van de Ven and Ellis 2000), and it necessarily underpredicts for persons with high *realized* costs. Figure 3 demonstrates the extent to which healthcare spending is highly right-skewed. The figure bins the sample population into 3 groups defined by utilization percentiles: [0, 90), [90, 99), and [99, 100]. Each of these groups corresponds to roughly one third of total spending. Because of the squaring property of a variance measure, the contributions to the variance in spending are even more highly skewed than the contributions to the mean spending. Among the 2M enrollees included in the simulations, the top 1% of the distribution accounts for 27.7% of the spending but 85.4% of the variance. This remarkable property of health care spending distributions largely explains the effectiveness of a seemingly modest reinsurance policy in achieving major improvements in measured fit. Reinsurance by design targets the upper tail of the patient distribution in cost. At the same time, reinsurance provides little or no reimbursement at the margin for the vast majority of plan enrollees, retaining high power for the majority of enrollees.

In 2017, when the payment system for Exchanges moves out of its transition phase, regulators plan to keep concurrent risk adjustment and drop reinsurance. Our results imply that from the perspective of power, fit, and balance it would be better to do the opposite: keep reinsurance and drop the risk adjustment.

We realize that this proposition strays from conventional wisdom about paying competing managed care plans, and more conceptual and empirical research is necessary to justify any radical change in policy direction. We identify a number of directions for future research to build on and confirm our initial findings. The first is to incorporate more features of Exchange payment systems and to simulate on updated data. Exchange payment systems include premiums, risk corridors (limiting gains and losses at plans) and plans with a higher or lower "actuarial value," referring to the share of total costs paid for by the plans. Adding consideration of these features will affect our fit and power measures, though we have no reason to expect that the inferiority of concurrent risk adjustment relative to feasible alternatives will change. Updated data, including eventually data from the Exchanges themselves, will enable a more accurate quantification of our performance metrics.

A second direction is to consider optimizing over the parameters of the payment systems features considered. Our paper takes the risk adjustment specification and the form of reinsurance as given in our simulations, but these could be modified and the effects studied on fit, power and balance. The cut point at which reinsurance activates and the reimbursement rate of reinsurance could be changed, for example, and the tradeoffs evaluated. Increasing the reinsurance share above the cut point improves fit, lowers power but has ambiguous effects on balance. Lowering the cut point improves fit, lowers power and improves balance. Variables included in the risk adjustment formula could also be modified. Both exercises would require new empirical analysis. New combinations of risk adjustment and other forms of payment can be explored. A risk adjustment system with only demographic adjustors improves fit at no power loss or introduction of imbalance. Such a system could be combined with reinsurance, for example, and improve fit relative to reinsurance alone with no cost in terms of the other two metrics.

Third, most of our analysis has implicitly assumed that there are no other margins of distortion aside from those directly embedded in the payment system itself. In the presence of additional distortions, second-best policy might not correspond with our notions, especially for the case of balance. For example, plans might seek to attract or deter enrollees by channeling resources towards or away from clinical areas. Such "service-level selection" might be countered with some intentional imbalance in power.[35] Further, if consumers make systematic errors in assessing the value of a certain medical technology, an imbalanced incentive for utilization of that technology could correct the information problem. We expect future empirical work to explore such additional complexities, including the interaction between the incentives created by imbalance and insurers' differential ability across clinical areas to respond to those incentives.[36] Nonetheless, we note that this paper already advances the understanding of second-best policy in insurance markets by providing the first analysis of the simultaneous impacts of several of the most common payment system mechanisms in the presence of multiple information and incentive problems. In particular, we focus on those problems that are most commonly targeted by regulators.

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[35] One measure of plan incentives for engaging in service-level selection is the "predictive ratio" for enrollees with a condition (Pope et al., 2012). The predictive ratio is the sum of total payments to total costs for the group. Ideally, this should be near 1.0. If it is lower, revenue is less than costs, and the plan has incentives to discourage membership from users of the service used to define the group.

[36] For example, higher power for birth events might incentivize lower Cesarean section rates, while higher power for AMI may have little impact if insurers can't as easily influence providers' choice of treatments.

Finally, as a fourth direction, each criterion we propose here may merit further development. While the concept of power is well-established in contract theory, our work is the first to apply it empirically to health plan contracting. The objective of balance is new and raises additional questions about the application of power-type measures to particular service areas.[37] Our payment systems $R^2$ measure of fit is the most standard of the three measures we propose, but the results with respect to fit were nonetheless the most striking and surprising. It was particularly notable to us how well reinsurance and mixed systems performed in terms of fit, since fit has been the metric of choice for proponents of risk adjustment. The finding implies that either the use of risk adjustment is correct and the fit objective that the risk adjustment literature seeks to maximize is the wrong target, or the fit objective is correct, and risk adjustment is simply inferior. Reinsurance and risk adjustment "explain" different parts of the distribution of costs, and it would be worth considering whether the square of the deviation from the mean captures in a single dimension all of the relevant incentives for cream-skimming and adverse selection distortions. If a different metric for evaluating the cream-skimming and adverse selection incentives of risk adjustment is proposed, we hope our explicit accounting of the performance metrics can help illuminate such future research.

## 6. Conclusions

Delegation of responsibility for providing health care services to managed care plans which compete on price and quality is the foundation of health policy in many countries, making the design of the payment system for health plans the most important regulatory task in health care. In a nearly universal practice, regulators apply risk adjustment formula to transfer funds to plans enrolling individuals with higher expected costs. Other payment features such as enrollee-paid premiums and reinsurance also generally contribute to plan payments. Our paper proposes and implements a method to grade alternative plan payment schemes based on one measure related to selection incentives—fit—and two measures related to incentives to supply services—power, and balance. To our knowledge these incentives have not been previously measured. Our paper develops a method for quantifying these incentives and thus comparing payment system alternatives. We assess the two major components of the ACA payment system, concurrent risk adjustment and

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[37] Importantly, the grouping of medical spending into categories will affect measured balance. We took what we thought was a natural approach here to illustrate the balance property of the payment systems studied, but alternative groupings may be appropriate as well.

reinsurance, separately and when combined on these three dimensions of performance, and compare them to prospective risk adjustment.

Our analysis illustrates one way in which the incentives implicit in diagnosis-based risk adjustment have been misunderstood. Rather than being influenced only by enrollee characteristics, risk adjustment is influenced by utilization, and therefore affects incentives to provide services. Concurrent risk adjustment, which ties diagnoses to payments in the same plan period, performs particularly poorly in this regard. Surprisingly, we find that a simple reinsurance scheme dominates the actual payment policy in the ACA Exchanges in term of fit, power, and balance.

The grading we outline formalizes and builds upon existing insights into payment systems incentives, capturing the main regulatory concerns in health insurance markets. Nonetheless, other criteria could be considered when assessing the relative merits of alternative payment schemes. Risk adjustment and reinsurance, for example, will differ in their incentives to "upcode" claims (Geruso and Layton 2014), in how well they respond to changing medical technology and practice patterns generally, and in costs of administration. Importantly, our work could be linked to other research on efficiency in health plan payment that focuses on the two adverse selection related issues of efficient sorting of individuals between plans (Einav, Finkelstein and Cullen, 2010), and on the incentives to plans to distort benefits to attract or deter enrollees based on their profitability (McGuire et al., 2014). A more comprehensive evaluation of risk adjustment in comparison to reinsurance and other payment options is necessary before making wholesale changes in the basis of payment to managed health care plans competing in markets for individual health insurance.

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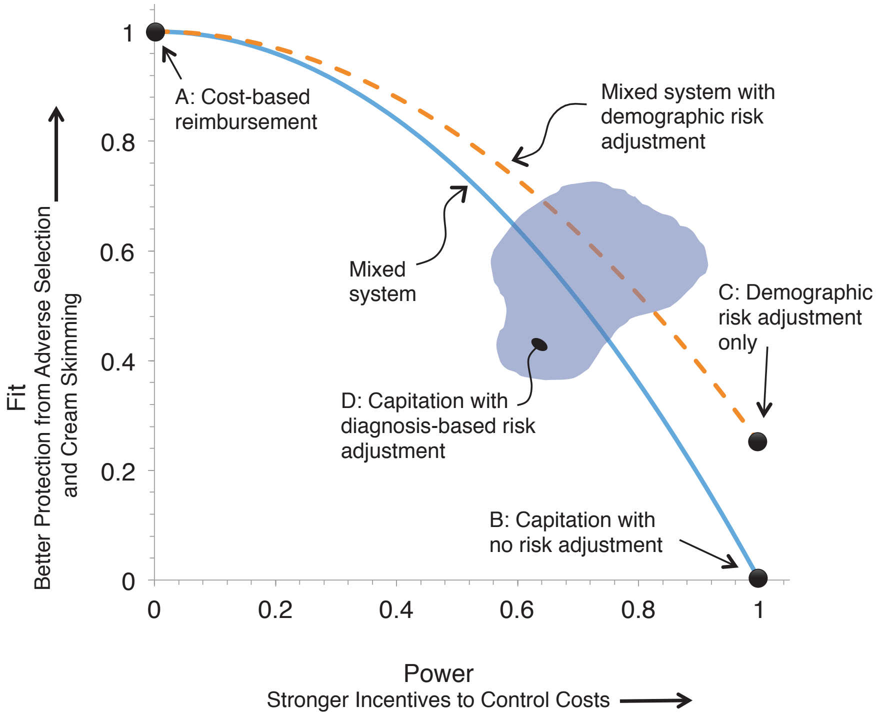
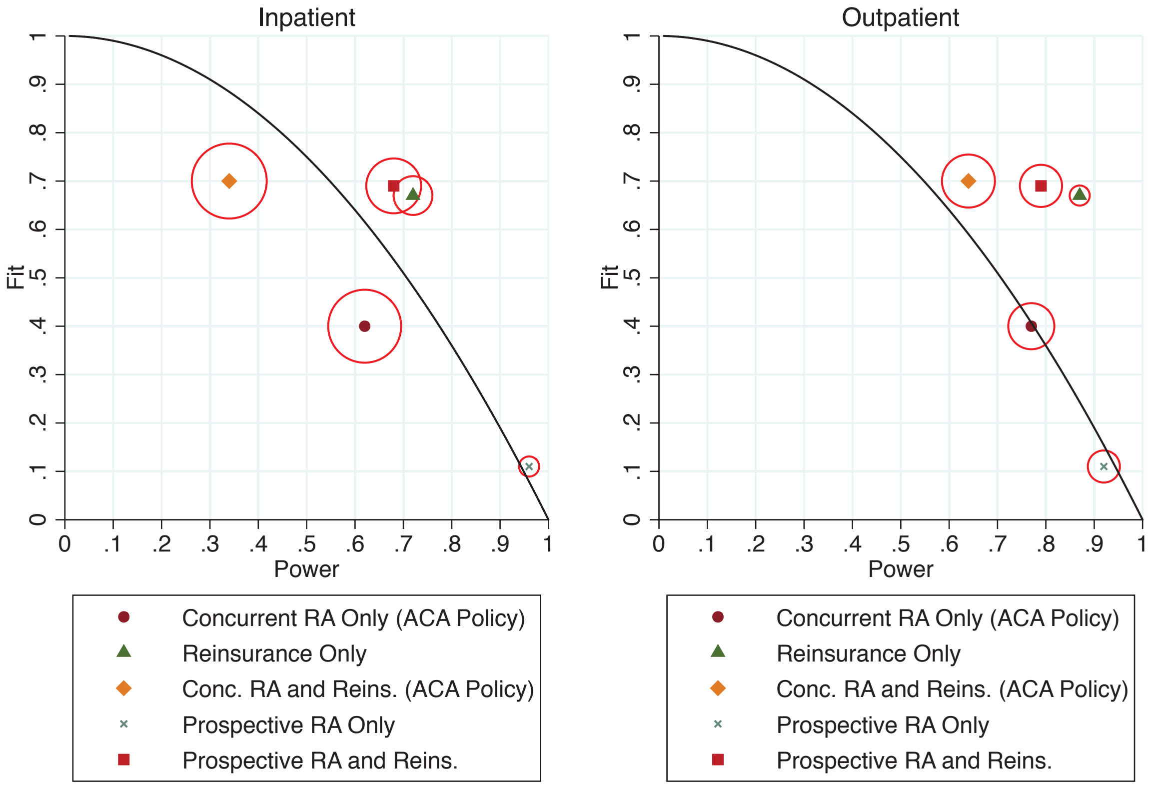
Figure 1: Power-Fit Tradeoff in Insurance Payment Systems



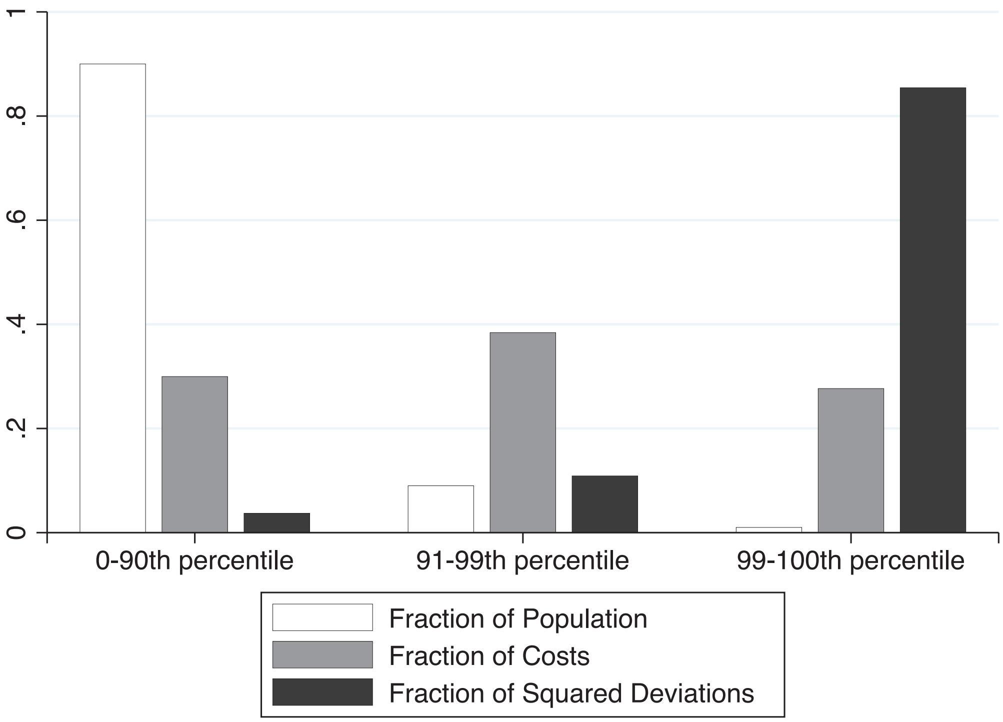
Notes: Figure illustrates the tradeoff between power and fit in insurance market payment systems. Fit, defined as the fraction of the variance of costs explained by payments as in Equation (1), is plotted along the vertical axis. Power, defined as the share of costs at the margin born by the health plan as in Equation (4), is plotted along the vertical axis. Points in black illustrate the exact fit-power combination for several payment system types. The solid and dashed curves trace the fit-power tradeoff in mixed systems over a range of parameter values for the weight put on the prospective portion of payment, as in Equation (2). The cloud at D illustrates the theoretically ambiguous set of potential points representing the incentives under capitation with diagnostic-based risk adjustment.

Figure 2: Fit, Power, and Balance under Risk Adjustment and Reinsurance in the Exchanges



Notes: Figure illustrates fit, power, and balance for several actual and counterfactual payment systems. Vertical and horizontal positions indicate fit and power. The size of the circle around each marker indicates imbalance, with the diameter proportional to the weighted variance of power across the MDCs examined. The solid curves trace, for reference, the theoretical fit-power tradeoff in a mixed system.

Figure 3: Skewness in Healthcare Spending



Notes: Figure shows distributions of costs and squared deviations of costs in the population, across groups defined by percentiles of individual costs: [0, 90), [90, 99), and [99, 100]. Vertical bars represent the fraction of the population within the percentile group, the fraction of total spending accounted for by the group, and the fraction of squared deviations accounted for by the group.

Table 1: Fit and Power Simulation Results

| | (1) | (2) | (3) |
|---|---|---|---|
| | Fit | Power | |
| Simulated Payment Scheme | | Inpatient Events | Outpatient Events |
| 1 Concurrent RA (ACA Policy, 2017+) | 0.40 | 0.62 | 0.77 |
| 2 Reinsurance | 0.67 | 0.72 | 0.87 |
| 3 Concurrent RA + Reinsurance (ACA Policy, 2014-2016) | 0.70 | 0.34 | 0.64 |
| 4 Prospective RA (100% Retention) | 0.11 | 0.91 | 0.85 |
| 5 Prospective RA + Reinsurance (100% Retention) | 0.69 | 0.64 | 0.72 |
| 6 Prospective RA (50% Retention) | 0.11 | 0.96 | 0.92 |
| 7 Prospective RA + Reinsurance (50% Retention) | 0.69 | 0.68 | 0.79 |

Notes: Table lists fit and power under several payment schemes. Rows (1) and (3) correspond to the actual payment policy in the ACA Exchanges, based on concurrent risk adjustment (RA) and reinsurance. Rows (2) and (4) through (7) consider several counterfactual policies. Fit in column (1) is measured as 1 - RSS/TSS in a regression of insurer payments on insurer costs. Power is calculated via a simulation in which healthcare events are randomly removed to determine the effect on insurer costs and payments at the individual level. Power for inpatient and outpatient events simulated separately. Consult the text for full details.

## Table 2: Balance of Power Across 11 Major Diagnostic Categories (MDCs)

| | Power by MDC | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Simulated Payment Scheme | Musculoskeletal System and Connective Tissue (MDC 8) | | Circulatory System (MDC 5) | | Digestive System (MDC 6) | | Factors Influencing Health Status (MDC 23) | | Skin, Subcutaneous Tissue and Breast (MDC 9) | | Nervous System (MDC 1) | | Respiratory System (MDC 4) | |
| | IP | OP | IP | OP | IP | OP | IP | OP | IP | OP | IP | OP | IP | OP |
| Share of Total Costs | 5.64% | 13.74% | 5.10% | 6.87% | 2.75% | 6.92% | 0.57% | 6.76% | 0.62% | 5.80% | 1.83% | 3.63% | 1.78% | 2.21% |
| Concurrent RA | 0.91 | 0.90 | 0.61 | 0.57 | 0.54 | 0.81 | 0.66 | 0.89 | 0.68 | 0.82 | 0.60 | 0.63 | 0.33 | 0.12 |
| ACA Reinsurance | 0.80 | 0.94 | 0.68 | 0.90 | 0.73 | 0.88 | 0.44 | 0.94 | 0.72 | 0.82 | 0.59 | 0.84 | 0.63 | 0.83 |
| Concurrent RA + Reinsurance | 0.71 | 0.85 | 0.28 | 0.47 | 0.26 | 0.69 | 0.12 | 0.83 | 0.38 | 0.64 | 0.18 | 0.46 | -0.03 | -0.04 |
| Prospective RA | 0.97 | 0.94 | 0.90 | 0.78 | 0.84 | 0.88 | 0.92 | 0.95 | 0.84 | 0.89 | 0.90 | 0.78 | 0.85 | 0.36 |
| Prospective RA + Reinsurance | 0.76 | 0.88 | 0.58 | 0.68 | 0.57 | 0.76 | 0.36 | 0.89 | 0.56 | 0.70 | 0.49 | 0.61 | 0.47 | 0.18 |

| | Power by MDC | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) | (26) |
| Simulated Payment Scheme | Pregnancy, Childbirth, and Puerperium (MDC 14) | | Kidney and Urinary Tract (MDC 11) | | Ear, Nose, Mouth, and Throat (MDC 3) | | Mental Diseases and Disorders (MDC 19) | | Range | | Weigthed Average of Squared Deviations | |
| | IP | OP | IP | OP | IP | OP | IP | OP | IP | OP | IP | OP |
| Share of Total Costs | 3.31% | 0.83% | 0.89% | 3.91% | 0.21% | 4.22% | 0.40% | 1.53% | | | | |
| Concurrent RA | 0.20 | 0.63 | 0.69 | 0.85 | 0.65 | 0.91 | 0.79 | 0.64 | 0.20 - 0.91 | 0.12 - 0.91 | 0.053 | 0.037 |
| ACA Reinsurance | 0.95 | 0.98 | 0.61 | 0.64 | 0.77 | 0.95 | 0.86 | 0.97 | 0.44 - 0.95 | 0.64 - 0.98 | 0.015 | 0.007 |
| Concurrent RA + Reinsurance | 0.16 | 0.61 | 0.31 | 0.49 | 0.38 | 0.86 | 0.64 | 0.61 | -0.03 - 0.71 | -0.04 - 0.86 | 0.056 | 0.049 |
| Prospective RA | 1.01 | 0.80 | 0.88 | 0.87 | 0.88 | 0.94 | 0.89 | 0.69 | 0.84 - 1.01 | 0.36 - 0.97 | 0.004 | 0.018 |
| Prospective RA + Reinsurance | 0.96 | 0.78 | 0.48 | 0.50 | 0.65 | 0.88 | 0.75 | 0.66 | 0.36 - 0.96 | 0.18 - 0.89 | 0.030 | 0.031 |

Notes: Table lists power by major diagnostic category (MDC) for each of the five payment systems considered. Each cell in columns (1) through (22) reports the power determined by a separate simulation in which 10% of the events associated with the indicated MDC are removed at random. For each of these, we report the average from five replications. IP in odd columns indicates inpatient events and OP in even columns indicates outpatient events. Columns (23) and (24) in the bottom panel list the range of power across MDC. Columns (25) and (26) display the weighted average of squared deviations of power across the 11 MDC categories shown. This weighted average is equal to the expression in Equation (6) normalized by the number of MDC categories.

## Appendix A: Balance and Efficiency

This appendix shows that the efficiency loss from imbalance in power can be approximated by expression (6) in the text.

Let ρ' be the optimal power across all services. As we note in the text, the optimal power of a payment system might not be 1, and we show here that Equation (6) measures loss due to imbalance for any combination of observed average power $\bar{\rho}$ and optimal average power ρ'. A ρ is optimal because it leads the plan to provide the optimal level of services, which we call $x_1'$ and $x_2'$ for services 1 and 2. Let $\rho_1$ and $\rho_2$ be the actual power for services 1 and 2, leading to service levels $x_1(\rho_1)$ and $x_2(\rho 2)$. We are interested in evaluating alternative payment systems in which the average power is held constant, i.e., where:

$$\bar{\rho} = \frac{\rho_1\overline{x_1}+\rho_2\overline{x_2}}{\overline{x_1}+\overline{x_2}}.$$

The inefficiency loss as a function of $\rho_1$ and $\rho_2$ we call $L(\rho_1, \rho_2)$. This loss can be approximated for one person (omitting i subscripts) with a Taylor series expansion of the function $L(\rho_1, \rho_2)$. The second order Taylor approximation simplifies to:[38]

$$L(\rho_1, \rho_2) \sim \frac{1}{2}\frac{\partial x_1}{\partial p_1}(\rho_1 - \rho')^2 + \frac{1}{2}\frac{\partial x_2}{\partial \rho_2}(\rho_2 - \rho')^2. \tag{a.1}$$

Assume proportional responses to power so that $\frac{dx_1/d\rho_1}{x_1} = \frac{dx_2/d\rho_2}{x_2} = \alpha$. Then, even though $\alpha$ is unknown, we can say:

$$L(\rho_1, \rho_2) \sim x_1(\rho_1 - \rho')^2 + x_2(\rho_2 - \rho')^2$$

If we sum this for the entire population, we replace $x_1$ by $\bar{x}_1$ and $x_2$ by $\bar{x}_2$, and write the equivalent expression:

$$L(\rho_1, \rho_2) \sim \bar{x}_1((\rho_1 - \bar{\rho}) - (\rho' - \bar{\rho}))^2 + \bar{x}_2((\rho_2 - \bar{\rho}) - (\rho' - \bar{\rho}))^2$$

Expanding, we have three groups of terms:

$$L(\rho_1, \rho_2) \sim \bar{x}_1(\rho_1 - \bar{\rho})^2 + \bar{x}_2(\rho_2 - \bar{\rho})^2 \qquad \text{(loss from imbalance)}$$

$$+ \bar{x}_1(\rho' - \bar{\rho})^2 + \bar{x}_2(\rho' - \bar{\rho})^2 \qquad \text{(loss from how } \bar{\rho} \text{ deviates from } \rho'\text{)}$$

$$-2(\rho' - \bar{\rho})[\bar{x}_1(\rho_1 - \bar{\rho}) + \bar{x}_2(\rho_2 - \bar{\rho})] \qquad \text{(zero by definition of } \bar{\rho}\text{)}$$

---

[38] Near the optimum of $\rho'$, $\frac{\partial L}{\partial p_j} = 0$ and Equation (a.1) follows directly from a second-order Taylor series expansion. The approximation assumes no "cross terms," i.e., the power of one service does not affect the supply of another. And it assumes the loss functions for each of $x_1$ and $x_2$ are the same (with identical first and second derivatives) near the optimum.

The last term is always zero. The middle term is the loss due to the gap between realized average power and optimal average power, and does not depend on $\rho_1$ and $\rho_2$. It is a constant when we compare payment systems with the same average power. Thus, only the first term varies as we change $\rho_1$ and $\rho_2$ keeping average power fixed. This first part, expression (6) in the text, is the contribution to inefficiency due to imbalance.

## Appendix B: Risk Adjustment Payments and Coefficient Estimates

**Risk Adjusted Payments:** In the simulations of the payment systems including risk adjustment, the plan payment for individual $i$ is assumed to be equal to the average cost in the sample (prior to randomly eliminating claims) multiplied by the individual's relative risk score:

$$\mathrm{Pay_i} = \frac{\mathrm{r_i}}{\bar{\mathrm{r}}}\bar{\mathrm{c}}.$$

This is motivated by the following risk adjustment transfer formula used in the Exchanges:[39]

$$\mathrm{t_i} = \left(\frac{\mathrm{r_i}}{\bar{\mathrm{r}}} - 1\right)\bar{\mathrm{P}}$$

where $\bar{\mathrm{P}}$ is the average premium in the market. If we assume that the market is perfectly competitive and that plan premiums equal average costs, then $\bar{\mathrm{P}} = \bar{\mathrm{c}}$. If we assume that all plans are identical, then the plan payment net of risk adjustment is equal to

$$\begin{aligned}\mathrm{Pay_i} &= \bar{\mathrm{P}} + \left(\frac{\mathrm{r_i}}{\bar{\mathrm{r}}} - 1\right)\bar{\mathrm{P}} \\ &= \frac{\mathrm{r_i}}{\bar{\mathrm{r}}}\bar{\mathrm{c}}\end{aligned}$$

In other words, plan payment for individual i is the average cost in the market, multiplied by i's relative risk score.

**Coefficient Estimates:** HHS provides a statutory set of risk adjustment coefficients—aka weights—for the concurrent model to be used in the Exchanges. We estimate our own vector of prospective weights, $\beta^{\mathrm{P}}$, and in order to ensure that the prospective and concurrent models we evaluate are comparable, we estimate our own vectors of concurrent weights $\beta^{\mathrm{C}}$ as well.

In all models, risk scores are calculated using the same vector of risk adjusters, $\mathrm{Y_i}$, used in the HHS-HCC model, so that only the coefficients attached to the risk adjusters may differ.. These risk adjusters consist of a set of age/sex cells, around 100 Hierarchical Condition Categories (HCCs), and a few interactions terms. [40] We use a program provided by HHS to generate these variables. The HCCs are generated using diagnoses from either the prior (prospective) or current (concurrent) year's claims. For each model, risk scores are assigned by multiplying the vector of risk adjusters by a vector of risk adjustment weights:

$$\mathrm{r^C}_{\mathrm{it}} = \mathrm{Y_{it}}\beta^{\mathrm{C}}.$$
$$\mathrm{r^P_{it}} = \mathrm{Y_{i,t-1}}\beta^{\mathrm{P}}$$

We estimate $\beta^{\mathrm{C}}$ and $\beta^{\mathrm{P}}$ using the portion of initial sample that was not selected as part of the random sample of 2,000,000 people we use in our simulations in order to avoid over-fitting. This estimation sample consists of around 15 million individuals. We estimate $\beta^{\mathrm{C}}$ and $\beta^{\mathrm{P}}$ via the following linear regressions of *total* costs on $\mathrm{Y_i}$:

---

[39] This is a simplified version of the actual Exchange transfer formula. The actual formula includes adjustments for age, actuarial value, geography, and induced demand. We abstract from these adjustments here.

[40] A detailed description of the HHS risk adjustment formula and downloadable algorithm are available at: http://www.cms.gov/CCIIO/Resources/Regulations-and-Guidance/

$$c_{it} = Y_{it}\beta^{C} + e_{it}$$
$$c_{it} = Y_{i,t-1}\beta^{P} + e_{it}$$

The coefficient estimates, normalized by dividing by $\bar{c}$, are found in Table B1. With the normalization, the coefficients indicate the contribution of each risk adjuster to the relative risk score. We use these weights combined with the risk adjusters, $Y_i$, to assign risk scores to individuals in our simulation sample.

Table B1: Estimated Coefficients from Risk Adjustment Regressions

| Variables | Concurrent Coefficient | Prospective Coefficient |
|---|---|---|
| Male, age 21-24 | 0.18 | 0.25 |
| Male, age 25-29 | 0.22 | 0.28 |
| Male, age 30-24 | 0.25 | 0.32 |
| Male, age 35-39 | 0.28 | 0.37 |
| Male, age 40-44 | 0.32 | 0.44 |
| Male, age 45-49 | 0.38 | 0.57 |
| Male, age 50-54 | 0.45 | 0.72 |
| Male, age 55-59 | 0.52 | 0.91 |
| Male, age > 60 | 0.59 | 1.11 |
| Female, age 21-24 | 0.31 | 0.57 |
| Female, age 25-29 | 0.38 | 0.78 |
| Female, age 30-24 | 0.45 | 0.79 |
| Female, age 35-39 | 0.49 | 0.70 |
| Female, age 40-44 | 0.53 | 0.69 |
| Female, age 45-49 | 0.56 | 0.76 |
| Female, age 50-54 | 0.60 | 0.84 |
| Female, age 55-59 | 0.62 | 0.93 |
| Female, age > 60 | 0.66 | 1.06 |
| HIV/AIDS | 0.42 | 0.63 |
| Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock | 11.68 | 2.51 |
| Central Nervous System Infections, Except Viral Meningitis | 5.11 | 1.16 |
| Viral or Unspecified Meningitis | 2.45 | 0.68 |
| Opportunistic Infections | 3.61 | 1.74 |
| Metastatic Cancer | 14.95 | 11.35 |
| Lung, Brain, and Other Severe Cancers, Including Pediatric Acute Lymphoid Leukemia | 6.25 | 5.28 |
| Non-Hodgkin's Lymphomas and Other Cancers and Tumors | 4.07 | 3.43 |
| Colorectal, Breast (Age < 50), Kidney, and Other Cancers | 3.91 | 2.70 |
| Breast (Age 50+) and Prostate Cancer, Benign/Uncertain Brain Tumors, and Other Cancers and Tumors | 2.28 | 1.31 |
| Thyroid Cancer, Melanoma, Neurofibromatosis, and Other Cancers and Tumors | 1.11 | 0.71 |
| Pancreas Transplant Status/Complications | 4.99 | 3.81 |
| Protein-Calorie Malnutrition | 8.59 | 2.23 |
| Liver Transplant Status/Complications | 10.55 | 3.40 |
| End-Stage Liver Disease | 3.52 | 5.49 |
| Cirrhosis of Liver | 1.28 | 2.37 |
| Chronic Hepatitis | 0.69 | 0.67 |
| Acute Liver Failure/Disease, Including Neonatal Hepatitis | 2.04 | 1.03 |
| Intestine Transplant Status/Complications | 28.22 | 20.70 |
| Peritonitis/Gastrointestinal Perforation/Necrotizing Enterocolitis | 13.36 | 2.26 |
| Intestinal Obstruction | 5.03 | 1.63 |
| Chronic Pancreatitis | 4.23 | 3.09 |
| Acute Pancreatitis/Other Pancreatic Disorders and Intestinal Malabsorption | 2.41 | 1.27 |
| Inflammatory Bowel Disease | 1.39 | 1.44 |
| Rheumatoid Arthritis and Specified Autoimmune Disorders | 1.34 | 1.48 |
| Systemic Lupus Erythematosus and Other Autoimmune Disorders | 0.68 | 0.88 |
| Cleft Lip/Cleft Palate | 1.44 | 1.11 |
| Hemophilia | 28.28 | 30.83 |
| Coagulation Defects and Other Specified Hematological Disorders | 2.00 | 1.04 |
| Schizophrenia | 1.36 | 1.03 |
| Major Depressive and Bipolar Disorders | 0.90 | 0.86 |
| Reactive and Unspecified Psychosis, Delusional Disorders | 1.94 | 1.06 |
| Personality Disorders | 0.67 | 0.67 |
| Anorexia/Bulimia Nervosa | 1.40 | 1.17 |
| Prader-Willi, Patau, Edwards, and Autosomal Deletion Syndromes | 2.86 | 1.14 |
| Down Syndrome, Fragile X, Other Chromosomal Anomalies, and Congenital Malformation Syndromes | 1.16 | 0.74 |
| Autistic Disorder | 0.28 | 0.45 |
| Pervasive Developmental Disorders, Except Autistic Disorder | 0.44 | 0.10 |
| Spinal Cord Disorders/Injuries | 4.28 | 1.65 |
| Amyotrophic Lateral Sclerosis and Other Anterior Horn Cell Disease | 2.08 | 3.42 |
| Quadriplegic Cerebral Palsy | 1.07 | 2.97 |
| Cerebral Palsy, Except Quadriplegic | 0.23 | 0.84 |
| Spina Bifida and Other Brain/Spinal/Nervous System Congenital Anomalies | 0.96 | 1.03 |
| Myasthenia Gravis/Myoneural Disorders and Guillain-Barre Syndrome/Inflammatory and Toxic Neuropathy | 2.97 | 2.47 |
| Multiple Sclerosis | 1.39 | 1.55 |
| Seizure Disorders and Convulsions | 6.63 | 1.13 |
| Hydrocephalus | 5.69 | 1.58 |

| | | |
|---|---|---|
| Non-Traumatic Coma, Brain Compression/Anoxic Damage | 9.16 | 1.26 |
| Respirator Dependence/Tracheostomy Status | 25.91 | 4.06 |
| Congestive Heart Failure | 2.42 | 2.02 |
| Acute Myocardial Infarction | 8.29 | 1.06 |
| Unstable Angina and Other Acute Ischemic Heart Disease | 4.38 | 1.17 |
| Heart Infection/Inflammation, Except Rheumatic | 4.03 | 1.21 |
| Specified Heart Arrhythmias | 2.23 | 1.15 |
| Intracranial Hemorrhage | 6.50 | 1.15 |
| Ischemic or Unspecified Stroke | 2.98 | 1.06 |
| Cerebral Aneurysm and Arteriovenous Malformation | 3.67 | 1.27 |
| Hemiplegia/Hemiparesis | 4.17 | 1.75 |
| Monoplegia, Other Paralytic Syndromes | 2.55 | 1.29 |
| Atherosclerosis of the Extremities with Ulceration or Gangrene | 6.91 | 4.05 |
| Vascular Disease with Complications | 4.85 | 1.61 |
| Pulmonary Embolism and Deep Vein Thrombosis | 8.29 | 1.44 |
| Lung Transplant Status/Complications | 18.13 | 13.17 |
| Cystic Fibrosis | 2.59 | 4.27 |
| Fibrosis of Lung and Other Lung Disorders | 1.72 | 1.15 |
| Aspiration and Specified Bacterial Pneumonias and Other Severe Lung Infections | 3.39 | 1.06 |
| Kidney Transplant Status | 6.38 | 4.85 |
| End Stage Renal Disease | 24.95 | 29.00 |
| Chronic Ulcer of Skin, Except Pressure | 1.56 | 1.79 |
| Hip Fractures and Pathological Vertebral or Humerus Fractures | 6.08 | 2.49 |
| Pathological Fractures, Except of Vertebrae, Hip, or Humerus | 1.12 | 0.67 |
| Stem Cell, Including Bone Marrow, Transplant Status/Complications | 17.78 | 3.71 |
| Artificial Openings for Feeding or Elimination | 7.04 | 2.27 |
| Amputation Status, Lower Limb/Amputation Complications | 4.13 | 2.81 |
| Group 01 | 0.58 | 0.72 |
| Group 02A | 1.55 | 1.13 |
| Group 03 | 4.39 | 1.82 |
| Group 04 | 2.67 | 1.55 |
| Group 06 | 7.70 | 5.40 |
| Group 07 | 5.08 | 3.83 |
| Group 08 | 3.45 | 3.24 |
| Group 09 | 2.49 | 1.78 |
| Group 10 | 8.45 | 4.95 |
| Group 11 | 6.77 | 4.43 |
| Group 12 | 1.09 | 1.23 |
| Group 13 | 12.02 | 1.72 |
| Group 14 | 21.79 | 9.27 |
| Group 15 | 0.68 | 0.66 |
| Group 16 | 1.39 | 4.75 |
| Group 17 | 0.95 | 1.20 |
| Group 18 | 2.57 | -0.14 |
| Interaction Group M | -4.98 | 1.00 |
| Interaction Group H | -3.00 | 1.31 |
| Severe Illness Indicator | -6.05 | -0.36 |
| Severe X Opportunistic Infections | 14.00 | 1.31 |
| Severe X Metastatic Cancer | 7.40 | 0.73 |
| Severe X Lung, Brain, and Other Severe Cancers, Including Pediatric Acute Lymphoid Leukemia | 6.44 | 0.33 |
| Severe X Non-Hodgkin's Lymphomas and Other Cancers and Tumors | 7.55 | 1.16 |
| Severe X Myasthenia Gravis/Myoneural Disorders and Guillain-Barre Syndrome/Inflammatory and Toxic Neuropathy | 7.13 | 0.42 |
| Severe X Heart Infection/Inflammation, Except Rheumatic | 7.94 | 0.53 |
| Severe X Intracranial Hemorrhage | 8.38 | -1.78 |
| Severe X Group 06 | 7.10 | 2.95 |
| Severe X Group 08 | 5.28 | 1.16 |
| Severe X End-Stage Liver Disease | 3.33 | 0.03 |
| Severe X Acute Liver Failure/Disease, Including Neonatal Hepatitis | 6.47 | -2.28 |
| Severe X Atherosclerosis of the Extremities with Ulceration or Gangrene | 7.51 | 2.78 |
| Severe X Vascular Disease with Complications | 7.56 | -2.01 |
| Severe X Aspiration and Specified Bacterial Pneumonias and Other Severe Lung Infections | 8.44 | -1.47 |
| Severe X Artificial Openings for Feeding or Elimination | 9.21 | -0.59 |
| Severe X Group 03 | 8.72 | 0.89 |

# Table B2: Group and Interaction Definitions

**Group 01**

Diabetes with Acute Complications
Diabetes with Chronic Complications
Diabetes without Complication

**Group 02A**

Mucopolysaccharidosis
Lipidoses and Glycogenosis
Amyloidosis, Porphyria, and Other Metabolic Disorders
Adrenal, Pituitary, and Other Significant Endocrine Disorders

**Group 03**

Necrotizing Fasciitis
Bone/Joint/Muscle Infections/Necrosis

**Group 04**

Osteogenesis Imperfecta and Other Osteodystrophies
Congenital/Developmental Skeletal and Connective Tissue Disorders

**Group 06**

Myelodysplastic Syndromes and Myelofibrosis
Aplastic Anemia

**Group 07**

Acquired Hemolytic Anemia, Including Hemolytic Disease of Newborn
Sickle Cell Anemia (Hb-SS)
Thalassemia Major

**Group 08**

Combined and Other Severe Immunodeficiencies
Disorders of the Immune Mechanism

**Group 09**

Drug Psychosis
Drug Dependence

**Group 10**

Traumatic Complete Lesion Cervical Spinal Cord
Quadriplegia

**Group 11**

Traumatic Complete Lesion Dorsal Spinal Cord
Paraplegia

**Group 12**

Quadriplegic Cerebral Palsy
Parkinson's, Huntington's, and Spinocerebellar Disease, and Other Neurodegenerative Disorders

**Group 13**

Respiratory Arrest
Cardio-Respiratory Failure and Shock, Including Respiratory Distress Syndromes

**Group 14**

Heart Assistive Device/Artificial Heart
Heart Transplant

**Group 15**

Chronic Obstructive Pulmonary Disease, Including Bronchiectasis
Asthma

**Group 16**

Chronic Kidney Disease, Stage 5
Chronic Kidney Disease, Severe (Stage 4)

**Group 17**

Ectopic and Molar Pregnancy, Except with Renal Failure, Shock, or Embolism
Miscarriage with Complications
Miscarriage with No or Minor Complications

**Group 18**

Completed Pregnancy With Major Complications
Completed Pregnancy With Complications
Completed Pregnancy with No or Minor Complications

**Severe**

Septicemia, Sepsis, Systemic Inflammatory Response Syndrome/Shock
Peritonitis/Gastrointestinal Perforation/Necrotizing Enterocolitis
Seizure Disorders and Convulsions
Respirator Dependence/Tracheostomy Status
Respiratory Arrest
Cardio-Respiratory Failure and Shock, Including Respiratory Distress Syndromes
Pulmonary Embolism and Deep Vein Thrombosis

**Interaction Group H**

Opportunistic Infections
Metastatic Cancer
Lung, Brain, and Other Severe Cancers, Including Pediatric Acute Lymphoid Leukemia
Non-Hodgkin's Lymphomas and Other Cancers and Tumors
Myasthenia Gravis/Myoneural Disorders and Guillain-Barre Syndrome/Inflammatory and Toxic Neuropathy
Heart Infection/Inflammation, Except Rheumatic
Intracranial Hemorrhage
Group 06
Group 08

**Interaction Group M**

End-Stage Liver Disease
Acute Liver Failure/Disease, Including Neonatal Hepatitis
Atherosclerosis of the Extremities with Ulceration or Gangrene
Vascular Disease with Complications
Aspiration and Specified Bacterial Pneumonias and Other Severe Lung Infections
Artificial Openings for Feeding or Elimination
Group 03

## Appendix C: Simulation Results Using HHS Concurrent Weights

Here we show comparability of results between the concurrent weights we estimate and those estimated by HHS. In table C.1, we replicate our main results using the statutory HHS weights. To do so, we use the same software that will be used by Exchange insurers to generate the risk scores that determine *ex-post* transfer payments across plans. For these simulations, the set of risk adjusters is the same as the set used in our prospective and concurrent models discussed above. Only the risk adjustment weights, $\beta^C$, differ.

Table C1. Fit and Power Simulation Results using HHS-HCC Statutory Coefficients

| | | (1) | (2) | (3) |
|---|---|---|---|---|
| | | Fit | Power | |
| Simulated Payment Scheme | | | Inpatient Events | Outpatient Events |
| 1 | Concurrent RA (ACA Policy, 2017+) | 0.35 | 0.60 | 0.70 |
| 2 | Reinsurance | 0.64 | 0.72 | 0.88 |
| 3 | Concurrent RA + Reinsurance (ACA Policy, 2014-2016) | 0.67 | 0.32 | 0.58 |

Notes: This table replicates results from Table 1 using the statutory risk adjustment coefficients (aka "weights") developed by the Department of Health and Humans Services, in place of the risk adjustment model calibrated for this paper. Rows 1 and 3 correspond to the actual payment policy in the ACA Exchanges, based on concurrent risk adjustment (RA) and reinsurance. Rows 2 considers reinsurance alone. Fit in column (1) is measured as 1 - RSS/TSS in a regression of insurer payments on insurer costs. Power is calculated via a simulation in which healthcare events are randomly removed to determine the effect on insurer costs and payments at the individual level. Power for inpatient and outpatient events simulated separately. Consult the text for full details.