Risk Adjustment of Health Plan Payments
to Correct Inefficient Plan Choice from Adverse Selection

Jacob Glazer, Thomas G. McGuire and Julie Shi*

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Abstract: This paper develops and implements a statistical methodology to account for the equilibrium effects (aka adverse selection) in design of risk adjustment formula in health insurance markets. Our setting is modeled on the situation in Medicare and the new state Exchanges where individuals sort themselves between a discrete set of plan types (here, two). Our "Silver" and "Gold" plans have fixed characteristics, as in the well-known research on selection and efficiency by Einav and Finkelstein (EF). We build on the EF model in several respects, including by showing that risk adjustment can be used to achieve the premiums that will lead to efficient sorting. The target risk adjustment weights can be found by use of constrained regressions, where the constraints in the estimation are conditions on premiums that should be satisfied in equilibrium. We illustrate implementation of the method with data from seven years of the Medical Expenditure Panel Survey.

 *JG is with the Department of Economics, The University of Warwick, and The Faculty of Management, Tel Aviv University. TGM is with the Department of Health Care Policy, Harvard Medical School and the NBER. JS is with the Department of Health Care Policy, Harvard Medical School. Correspondence: mcguire@hcp.med.harvard.edu.

1. Introduction

In the U.S. and a number of other countries, individuals choose health insurance from among competing health plans. The Affordable Care Act (ACA) mandates previously uninsured individuals choose a plan offered in the new state-level Health Insurance Exchanges. Parts C (managed care plans) and D (drug plans) in Medicare use private health insurance markets, as do the national health care systems of the Netherlands, Germany, Switzerland and other countries. A fundamental premise of payment regulation in all of these markets is that plans' revenue should be "risk-adjusted" to account for cost differences among enrollees. Risk adjustment protects plans and mitigates incentives related to adverse selection. The risk adjustment formulas can be complicated, as they are in the ACA where they involve demographics, scores of diagnostic variables, and interactions. Weights on risk adjuster variables, like age or diagnoses for certain conditions, are generally derived from regression-based statistical procedures on data sets with millions of people.

A well-known limitation of risk adjustment methods is that the weights are sometimes estimated from data not from the plans paid by risk adjustment. For example, in Medicare, private managed care plans are paid with a risk adjustment system estimated with data from beneficiaries who elect *not to join* one of the private plans. In the new Exchanges, the risk adjustment formulas the federal government recommends are estimated from employees of large employers and their dependents, individuals generally not eligible to participate in Exchanges.

The issue is partly practical and temporary in the sense that once data from Exchanges accumulate or Medicare private plans report more complete data, weights can be recalculated based on the "real data." But there is a more fundamental problem access to data doesn't solve: Statistical procedures make risk adjustment weights a function of the data, and, economic equilibrium makes the data a function of the risk adjustment formula. In other words, the risk distribution of individuals who choose to join a plan, and even the services a plan decides to offer to its enrollees, are a function of how plans are paid. This is more than a technical concern – equilibrium effects on enrollment and services are precisely the adverse selection problems risk adjustment is designed to avoid.[1]

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[1] Another way to say this: if risk adjustment didn't affect enrollment and/or services offered, there would be no need to risk adjust. The law of large numbers would deal with any plan-level risk.

This paper develops and implements a statistical methodology to account for the equilibrium effects (aka adverse selection) in design of risk adjustment formula in health insurance markets. We focus on the "Einav-Finkelstein" form[2] of adverse selection in which enrollees sort between plans with fixed benefit offerings as a function of the plans' premiums. Because these premiums do not reflect each person's marginal costs, the plan with the better coverage tends to be a bargain for the sick and too expensive for the healthy, leading some people to choose the wrong plan.[3] We show that risk adjustment affects the equilibrium sorting, and can be used to improve upon the adverse selection outcome. We find the "second-best" allocation between plans, second best meaning the most efficient that can be achieved given the premium categories available, and then show how choice of risk adjustors can attain this second-best outcome.

Section 2 reviews the literature, highlighting recent papers by Einav and Finkelstein (EF) which study enrollee sorting between plans with fixed characteristics charging the same premium to all enrollees. Section 3 incorporates risk adjustment into the EF framework, oriented around the working of the ACA. We retain the EF assumption that there are two plan types (which we call Silver and Gold) with fixed characteristics and build on EF in a number of ways: in addition to introducing risk adjustment, we allow for many premium categories (for example, premiums conditioned on age). We also incorporate an explicit model of selection in which individuals choosing between plan types make imperfect forecasts of their future health care costs. The nature of adverse selection is critical to efficiency interpretations of an EF model. The fundamental normative implication of the EF model is that when a more generous plan experiences adverse selection, the "Gold Plan" premium should be subsidized to encourage more enrollment than would occur in competitive equilibrium. We show: 1) the optimal subsidy should correct for individuals' imperfect forecasts in addition to the "marginal-average cost gap" in the EF model; 2) the resulting allocation minimizes but does not eliminate inefficiencies in sorting (i.e., is a second best), and 3) the optimal subsidy can be achieved by risk adjustment.

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[2] E.g., Einav and Finkelstein (2011), Einav, Finkelstein and Levin (2010), and Einav, Finkelstein and Cullen (2010).

[3] Major precursors of the Einav-Finkelstein paper are Cutler and Reber (1998) who studied sorting in the benefit plans at one employer, and before that and more generally, Akerloff (1970). The second form of adverse selection in health insurance markets stems from Rothschild and Stigliz (1976) in which plan offerings are not fixed and plans distort benefit offerings to attract less costly enrollees. Glazer and McGuire (2000) used the Rothschild-Stiglitz model to draw the implications for risk adjustment in health insurance.

Section 4 implements the theoretical ideas with data from seven years of the Medical Expenditure Panels Survey (MEPS), drawing a population representative of those eligible for Exchanges in the ACA. Operationalizing the model from Section 3 requires simulating the payment system in Exchanges, specifying costs in the Gold and Silver plans, and specifying the underlying demand (selection) behavior. Importantly, the regulator needs to know the nature of the inefficiency due to selection in order to design the right risk adjustment system to correct the inefficiency.

Empirical results are contained in Section 5 where we evaluate several equilibria in terms of the efficiency of plan sorting and in the degree to which the payment system associated with risk adjustment "fits" costs at the Silver and Gold plans (in equilibrium). We start with no risk adjustment where premiums for twelve age-geography categories are determined in equilibrium between competing Gold and Silver Plans. The welfare loss from sorting is high and the fit of plan costs is poor. Conventional risk adjustment, of the type proposed in the ACA, improves sorting and improves the fit of play payments to cost. We then show how a modification of conventional risk adjustment methods can set risk adjustment weights so that in equilibrium, the incremental premium for the Gold plan leads to the efficient (second-best) sorting. The method is constrained regression, were the constraints (on the risk adjustment weights) require that risk adjustment transfer sufficient funds to the premium group to achieve the desired subsidy in equilibrium.

2. Background and Literature Review

A foundation of the policy of managed competition, and of the many regulated health insurance markets based on the idea, is that consumers choose among competing health plans in the presence of prices that reflect the additional costs of more versus less generous plans. In the U.S. Medicare program, for example, competing private health plans can add benefits over the required minimum but must finance these by higher premiums. The ACA creates an ordered set of plans designated Bronze, Silver, Gold and Platinum with more coverage for higher prices.

Consumer utility maximization leads to efficient sorting among plans if consumers face premiums that present them with the "incremental cost" of benefits in the more generous plan (Keeler, Carter and Newhouse, 1998). The argument is the same as that for prices generally: when consumers face prices equal to costs, net utility equals social welfare and consumers make

efficient choices. The problem is that managed competition does not deliver the required incremental prices (Bundorf, Levin, Mahoney, 2012; Glazer and McGuire, 2011). When the product is health insurance, incremental cost is person-specific. In other words, the incremental cost across two plans differs for each person depending on their expected health care costs. Asymmetric information between plans and enrollees interferes with efficient pricing. Furthermore, managed competition policies purposefully limit the degree to which plans may price discriminate based on observables related to health care costs. Higher premiums for those with previous illnesses are, for example, nearly universally prohibited. (The ACA also has age-band restrictions.)

Managed competition policies rely on risk adjustment of payment to plans in order to pay more for higher-cost enrollees. While this deals with some aspects of efficient plan service provision, it may not help at all with consumer sorting among plans. Our main objective in this paper is to study how risk adjustment payments schemes, set by a regulator, can affect the premiums that plans charge enrollees, which in turn will affect enrollees choice of plans and, hence, welfare. We build on the model introduced in a series of papers by Einav and Finkelstein, primarily the well-known Einav, Finkelstein and Cullen (2010). We will refer to the model as the "EF" model, and review its basics here.

The EF model shows how to measure the welfare losses due to adverse selection using demand and cost curves. Einav, Finkelstein and Cullen (2010) outline a stylized version of their approach and discuss its application in different settings. In what they refer to as their "textbook example," consumers choose between a high-coverage contract, H, and a low-coverage contract, L. In their example the L contract refers to no insurance and, hence, it is costless to all consumers and is free. The (incremental) price of the H contract is denoted by p paid by all potential enrollees, and consumers purchase the H contract if their valuation of it, net of the price p, exceeds their valuation of the low contract, normalized to zero. As premium falls, new enrollees choose H, defining an average and marginal cost curve. For a given price p, average cost for plan H (denoted by AC(p)) is the expected costs of the enrollees, who (endogenously) choose to enroll in contract H, divided by the number of individuals who purchase it. For a given price p, marginal cost (denoted by MC(p)) is the expected cost for the individual(s) whose willingness to pay is exactly p. See Figure 1, a replica (omitting some labeling) of Figure 1 in Einav, Finkelstein and Cullen (2010).

In market equilibrium, insurers are assumed to price competitively, such that p = AC(p). As in a standard welfare analysis, consumer surplus for a given individual in the high contract is measured by their willingness to pay for the H contract minus the price, and producer surplus for a given individual is measured by price minus the cost of that individual. The efficient price (premium) and quantity (enrollment in H) are given by the point where the marginal cost intersects demand, and the equilibrium price and quantity are given by the point where the average cost intersects demand. The efficiency loss, in their setting, is given by the "conventional" welfare triangle bounded by the marginal cost and demand curve, between the efficient quantity and the equilibrium one (the shaded area in Figure 1).[4] In their empirical application using data on insurance choices and costs from a large employer, Einav, Finkelstein and Cullen detect adverse selection, but they estimate the welfare costs of adverse selection to be small.[5]

We modify and extend the basic EF model in several ways to further illuminate properties of markets with insurance choice.[6] The first has to do with the relationship between willingness to pay and costs. In the "textbook case," the ordering in willingness to pay of those who join as a function of p is matched by a one-to-one ordering of falling costs. As was acknowledged by Einav, Finkelstein and Cullen (2010), if individuals' costs are not monotonically increasing or decreasing with willingness to pay, as generally they will not be, then the point where marginal cost intersects the demand will not be first best and the welfare triangle in Figure 1 will not describe the welfare loss.[7] The reason is that with heterogeneity in the relationship between demand and incremental cost, "marginal cost," MC(p) is, in fact, an average of the marginal costs over all individuals whose willingness to pay is exactly p. Thus, even when MC(p) = p, there are individuals (those whose willingness to pay is higher than p but

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[4] There are two cases, the "adverse selection" case, where individuals' willingness to pay for plan H is increasing with their cost (to the plan) and the other, the "advantageous selection" case, where individuals' willingness to pay cost is decreasing with their cost. In the adverse selection case, the one shown in Figure 1 and the one we work with in this paper, the welfare loss is due to the fact that "too few" individuals join the H plan, relative to social optimum.

[5] The authors also discuss how the welfare losses (gains) from imperfect competition or discriminatory prices can be quantified. They also compare the estimated welfare loss to the social cost of subsidized prices or mandates.

[6] Kolstad and Kowalski (2012) use a modification of the Einav, Finkelstein and Cullen (2010) model to study the reduction in adverse selection as a results of an "individual mandate" in the recent reform in Massachusetts.

[7] See their footnote 3.

their cost is higher than their willingness to pay) who join the plan even though, from social point of view, they shouldn't, and there are individuals (those whose willingness to pay is less than p but their cost is lower than their willingness to pay) who will choose not to join the plan even though, from social point of view, they should. Another way to say this is that only in the very special circumstances assumed in the textbook version of the EF model is a single premium (equal to MC) able to eliminate welfare loss from sorting.[8] In general, the situation will be as depicted in Figure 2. Two groups (here 1 and 2) have different incremental marginal costs and demand, but must share a common incremental premium (Δp). Any Δp is associated with welfare losses. The second-best analysis we perform later essentially seeks to minimize the sum of the losses, L_1 and L_2 in the Figure, as a function of the incremental premium. An example of the welfare losses that will emerge with heterogeneity is that under the ACA, plans cannot discriminate in premium across individuals with different health status or other characteristics that may affect their costs. In our analysis we allow for individual heterogeneity at the margin in our welfare analysis.[9]

Second, we consider a "real" alternative plan and take account of what is happening in equilibrium for this plan as the distribution of risks shifts in response to changes in the incremental premium for the high-coverage (Gold) plan. When the "other plan" is not a zero-cost plan, the average costs and equilibrium premium in that plan also change as demand changes for the Gold plan. This modifies the interpretation of the EF textbook diagram and is essential in an empirical application of payment systems.

Third, we allow for individuals' willingness to pay for a plan to differ from their (social) benefit from that plan.[10] If, for example, individuals are not fully informed about their health cost risk, or cannot fully understand their risks, they will not accurately anticipate the services

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[8] This point is emphasized by Bundorf, Levin and Mahoney (2012). Commenting on analyses which imply a single premium can efficiently sort a population between two plans, they observe, "These analyses, however, assume perfect correlation between enrollee risk and preferences for coverage and make strong assumptions about the relationship between preferences and plan costs. We show that if these assumptions are violated, a uniform contribution policy (i.e., a policy under which individuals face the same prices for the plans) cannot induce efficient consumer choices." (page 3215). Glazer and McGuire (2011) show that in general a single-premium policy cannot lead to efficiency.
[9] Spinnewijn (2013) considers a different explicit model of selection in which "demand frictions" introduce heterogeneity and affect choice. He also finds that the welfare economics of the standard selection model are altered.
[10]See Abaluck and Gruber (2011) for an example of an analysis of "mistakes" in buying health insurance made by the elderly in choosing their drug plans in Medicare.

they will receive upon joining a particular plan. They may over or underestimate how much they have to gain from joining the H plan. This issue is tied to adverse selection, because it is just this anticipation that drives the higher cost people to join the H plan. As long as this process is imperfect, that is, the anticipation is only partial, then consumers will make "mistakes" in their plan choice. In such a case, demand and marginal benefit curves do not generally coincide and even if price is equal to marginal cost, equilibrium will not be socially efficient.

Fourth, we enrich the payment system studied and introduce multiple premium categories and risk adjustment. In the ACA, plans can discriminate on the basis of age (within limits), geography and smoking status. Furthermore, risk adjustment will move funds to plans drawing a sicker population, affecting equilibrium premia and consumer sorting. We explicitly incorporate the effect of risk adjustment within an EF model, and show that an appropriately designed risk adjustment payment scheme may reduce welfare losses associated not only with EF adverse selection but also with individuals' inability to perfectly evaluate the services they will receive if they join a plan.

Our paper is also related to a number of other recent papers that have studied the welfare implications of policy changes or changes in the market conditions in the health insurance market. A comprehensive review of this emerging literature is contained in Einav, Finkelstein and Levin (2010). Recent papers have specified more complete models of consumer preferences to enable a more thorough normative interpretation of market outcomes. These models allow authors to quantify the magnitude of welfare loses from, among other things, distortionary pricing (see Bundorf, Levin, Mahoney (2012), Carlin and Town (2010), Geruso (2012) and Handel, Hendel, and Whinston (2013)), restrictions on the choice set (see Lustig (2008), Dafny, Ho, and Varela (2013), Lucarelli, Prince, and Simon (forthcoming)), and changes in the allocation of consumers to plans (see Handel (2011), Lustig (2008)).

3. Risk Adjustment to Fix Adverse Selection

This section presents a model of a health insurance market with regulated benefits and two types of competing plans which we refer to as Silver plans and Gold plans. Enrollees face premiums and choose a plan. We allow multiple premium categories and risk adjustment. Our risk

adjustment system pays the same for an individual independent of what plan they join.[11] As in the standard EF model, we describe equilibrium and efficient sorting between plan types, and identify the efficient incremental premium for the Gold Plan for each premium category.

3.1 Costs and Demand for Health Plan Alternatives

N people in an insurance pool vary in two observable dimensions, according to health status, the basis of risk adjustment, and according to another set of characteristics, the basis of premiums. Health status is indexed by h, h = 1,…,H; premium characteristics are indexed by t, t = 1,…,T. Each categorization is mutually exclusive so that a person is characterized by an (h,t) pair. There can be overlap between the factors (e.g., age might be a used in both h and t), but there is some independent information about health care costs in each of h and t. For example, geography might be used as a basis for premiums but not risk adjustment and prior health conditions might be a basis for risk adjustment but not premiums. We will refer to a person with characteristics h and t as a person of type ht. N_{ht} is the number of people of type ht in the population and N_t is the number of people with premium type t.[12]

Plans provide services, x, according to h and t, and services a person of type ht would get are fixed in each plan. Gold is more generous so that $x_{ht}^g > x_{ht}^s$ for all ht, with x measured in dollars. x_{ht}^g and x_{ht}^s are thus also the costs of serving a person of type ht in the Gold and Silver plans respectively. Define the incremental costs for a person of type ht as $x_{ht} \equiv x_{ht}^g - x_{ht}^s$. For simplicity in presentation, we let incremental cost x_{ht} represent both social incremental cost and plan incremental cost, implying that the out-of-pocket costs to an ht type are the same in Silver and Gold.[13]

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[11] The model captures features of the managed competition approach to individual health insurance which serves as the intellectual basis of ACA Exchanges, Medicare Parts C and D, and health policy in a number of European countries.   Premium subsidies are a feature of all of these policy contexts. Incremental premiums (the difference between Gold and Silver) govern sorting and efficiency so we can be agnostic about whether there are subsidies for the basic plan type. Our approach is also consistent with "premium-support" policies awarding a risk-adjusted voucher to enrollees who can apply the voucher towards premium at any plan.

[12] A similar model of plan costs is used in McGuire et al. (forthcoming) for one plan type. That paper shows how to choose risk adjustment weights when premiums also contribute to fit but the premiums are determined in market equilibrium.

[13] Premiums of course will differ between plans. In Exchanges, Gold plans have more coverage, so part of more services would be due to moral hazard in demand. Keeping track of out-of-pocket differences would complicate the presentation of the accounting in this paper without adding insight.

Although every member of type ht gets the same increment in services going from Silver to Gold, individuals are heterogeneous in their valuation of Gold over Silver plans. Demand is $n_{ht}(p_t)$, the number of people among type ht who choose to enroll in the Gold plan as a function of the incremental premium for members of this premium type, where the incremental premium is the difference between the Gold and Silver plan premiums for that premium group: $p_t \equiv p_t^g - p_t^s$. Heterogeneity in demand could be due to tastes for health care services, risk aversion or other preferences regarding cost management methods in the two plans. As in EF, our normative framework includes these preferences as a component of welfare. We assume demand is downward-sloping: $n'_{ht}(p_t) < 0$. The Gold plan's "aggregate" demand function of individuals in premium category t sums enrollment demand over the h categories:

$$n_t(p_t) = \sum_h n_{ht}(p_t) \qquad\qquad (1)$$

The corresponding "inverse" demand function of each ht type is $p_{ht}(n_{ht})$, and the "inverse" aggregate demand, $p_t(n_t)$.

"Demand" can be distinct from "benefit" in the context of selection and insurance choice. Selection is driven by consumers being able to anticipate their health care costs, but they do so imperfectly. Consumers are therefore also generally imperfect in their anticipation of how much they would benefit from membership in alternative health insurance plans, introducing a distinction between what consumers *anticipate* in terms of benefits and what they *actually get* in terms of benefits of plan choice. Demand is based on what consumers anticipate *ex ante*, whereas welfare is naturally based on *ex post* benefits.

3.2 Efficiency

When enrollees know their type ht and face incremental premiums equal to the incremental cost, x_{ht}, their utility-maximizing choice of plan type achieves efficient sorting. However, since incremental premiums can be conditioned only on t and not on h, first-best sorting between Gold and Silver plans is generally impossible. With the first-best unattainable, we characterize the premiums that minimize the welfare loss from inefficient sorting, assuming that people know their type, and subject to the constraint that premiums must be the same for all persons with the same t.

For a premium group t, the common incremental premium that maximizes social welfare solves the following problem:

$$\text{Max}_{p_t} \ \Sigma_h \left[\int_0^{n_{ht}(p_t)} p_{ht}(n_{ht}) \, dn_{ht} - n_{ht}(p_t) x_{ht} \right] \tag{2}$$

Recall that $n_{ht}(p_t)$ is the demand function of the ht types and $p_{ht}(n_{ht})$ is its inverse. When consumers know their type demand has the conventional interpretation as willingness to pay or consumer surplus. x_{ht} is the cost of an individual of type ht moving from Silver to Gold.

Assuming an interior solution (members from all h groups are in both the Gold and Silver Plans), the solution to (2) is p_t^*:

$$p_t^* = \frac{\Sigma_h \, n'_{ht}(p_t^*) x_{ht}}{\Sigma_h \, n'_{ht}(p_t^*)} \tag{3}$$

We state this result formally:

Proposition 1: Assuming demand indicates benefit, the welfare-maximizing incremental premium for premium group t equals the Gold plan's incremental cost averaged over the h groups joining the plan.

Proposition 1 extends the EF result by showing that the incremental premium should equate (averaged) incremental marginal cost to demand even when there is heterogeneity in the mix of persons joining Gold as a function of premium.

The EF analysis and Proposition 1 share the important assumption that individuals can accurately forecast their expected cost. When this is not true, Proposition 1 must be modified. Equating incremental marginal cost to marginal benefit is then not the same as equating marginal cost to demand. The efficient second-best premium must also correct for the gap between expected and actual benefit of joining Gold.

3.3 Equilibrium with Risk Adjusted Payments and Selection

Equilibrium consists of premiums for each of the T premium categories for the Silver and Gold plans, and of an allocation of enrollees across the plan types. The equilibrium will be a function of the risk-adjustment formula. Let r_h denote the risk adjustment payment that (Gold or Silver) plans receive for each individual of type h. Suppose, as in Exchanges, the risk adjustment system is financed by premium payments of enrollees. We can regard a plan paying into a risk adjustment fund a constant amount for each enrollee, perhaps, as here, set equal to costs at the Silver plan averaged over the entire population, $\bar{x}^s$. The plan (either Gold or Silver) then receives r_h back from the fund for each person of type h joining the plan. The risk adjustment system is balanced budget if $\Sigma_h \, N_h r_h = N \bar{x}^s$. Plans must charge premiums that cover

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costs (after risk adjustment) according to each t group. (The "budget constraint" for risk adjustment, $\overline{x}^s$, could be set at some other level, affecting the equilibrium premiums plans must charge.)

The premium for the Silver plan for type t is p_t^s. We can write the Gold plan premium as $p_t^s + p_t$, the Silver plan premium plus the incremental premium for group t. Risk adjustment is set the by a regulator, and premiums are determined in market equilibrium. We assume that competition drives the profit for Silver and Gold plans to zero for each premium group. Thus, for each t we have two zero-profit conditions:

$$\sum_h (r_h - \overline{x}^s + p_t^s - x_{ht}^s)(N_{ht} - n_{ht}(p_t)) = 0, \tag{4}$$

$$\sum_h (r_h - \overline{x}^s + p_t + p_t^s - x_{ht}^g)\, n_{ht}(p_t) = 0. \tag{5}$$

where $N_{ht} - n_{ht}(p_t)$ is the number of individuals of type ht in the Silver plan, and $n_{ht}(p_t)$, defined in (1) above, is the number in the Gold plan

Conditions (4) and (5) incorporate utility maximization as well as competitive equilibrium among plans and thus describe a complete equilibrium in the insurance market, given a risk adjustment system with weights, r_h.

3.4 Risk Adjustment Weights that Achieve (Second-best) Efficient Sorting

The 2T equations in (4) and (5) describe a relationship between the risk-adjustment weights, r_h, and the equilibrium premiums, p_t. The idea is to take this relationship into account when deciding risk adjustment policy; specifically, to set the weights, r_h, so that the equilibrium premiums hit the desired target. When demand represents benefit, risk adjustment weights that achieve efficient sorting in equilibrium satisfy (3), subject to (4) and (5). Each of the T premium categories generates an equation describing the condition for second-best p_t and a pair of zero-profit conditions. Substituting the equations for premiums, (4) and (5), into the efficiency condition (3) yields equation in the risk adjustment weights, r_h. After these substitutions, there are T equations. The "unknowns" are the H risk adjustment weights, r_h. In general there are relatively few premium categories in individual health insurance markets (e.g., age categories), and many risk adjustment weights (age, gender, many diagnostic conditions). We refer to a set of weights that solve the T equations for efficiency as r_h^{sb}.

With T<<H, as is typical (in the standard EF model, T = 1), there are many r_h^{sb} solutions. How should we pick among these many alternatives? The luxury of multiple solutions allows

pursuit of a second criterion in the choice of weights, the fit of the payment system, which, in the case of both MA and Exchanges, consists of a risk adjustment system and enrollee premiums. Assessing and maximizing fit in a particular institutional context requires incorporation of payment rules, and data, both of which are introduced next.

4. Empirical Application: Gold Plan Incremental Premiums and Risk Adjustment

We draw an "Exchange population" from the Medical Expenditure Panel Survey (MEPS) to implement the efficient (second-best) incremental premiums. Risk adjustment weights are set by a Regulator; premiums are determined in market equilibrium. Taking advantage of the multiple solutions available via risk adjustment, we use constrained regression methods to find the risk adjustment weights that do the best job of fitting plan payments to costs subject to achieving the efficient incremental premiums. Our purpose is to develop and illustrate the application of a method for using risk adjustment to correct for selection problems. We model key features of Exchanges – the population, the plans, the premium and risk adjustment with MEPS data.

4.1 Data and the Exchange Population

MEPS is a nationally representative survey of the civilian non-institutionalized U.S. population conducted annually since 1996. Each year MEPS collects information on approximately 33,000 individuals, enlisting a new panel of respondents followed for two years. Data are collected in five rounds of interviews covering the two-year period. The Household Component (HC) is the source for personal and household characteristics, including insurance coverage and self-reported health and health conditions. The HC is also the source of data on medical "events" (e.g. an inpatient stay or office visit) including information about diagnoses, procedures, and payments from various sources. The HC data are supplemented with information from the Medical Provider Component (MPC), based on phone surveys of hospitals, physician offices, pharmacies, and home health agencies. We use data from 2004 through 2010. MEPS data understate health expenditures (Sing et al., 2002; Aizcorbe et al., 2012; Zuvekas and Olin, 2009). We follow the correction proposed by Zuvekas and Olin (2009) to inflate total

expenditures by a factor of 1.09 for individuals with an inpatient claim and by a factor of 1.546 for all other claims.[14]

We select a population of adults who would be eligible to enroll in state-level Exchanges under current law based on their income, insurance, and employment status. We identify non-elderly individuals (aged 19-64) in households earning at least 138% of the federal poverty level.[15] We select those who live in a household where an adult is ever (in either year) uninsured, a holder of a non-group insurance policy, self-employed, employed by a small employer, or paying an out-of-pocket premium for their employer-sponsored health insurance (ESI) plan that is deemed to be unaffordable (as defined in the ACA).[16] We include both years of data for a person who would qualify for Exchanges in either year of the data, with the idea that these individuals are vulnerable to loss of insurance and share the same distribution of health care costs as persons who would enroll in Exchanges. In total, we have 64,667 person years.[17] Children may also be in Exchanges, but since they are paid with a separate risk adjustment system, we confine the analysis here to adults.

Table 1 summarizes some statistics on this group. The population contains a relatively high proportion of Hispanics and lives disproportionately in the South. The education and income range is large because we include persons who may have health insurance but in the individual or small-group market. By in large, this is a relatively healthy population, with 60% rating their health Excellent or Very Good. Average health care spending from all sources was $2,648 in 2010 dollars.

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[14] MEPS surveys the "noninstitutionalized" population and underrepresents persons in nursing homes or with very long hospital stays. This also contributes to underreporting average medical expenses, but has a small effect on an Exchange population.

[15] Annual household income from each year is inflated to 2010 dollars using the Consumer Price Index (CPI-U) published by the Bureau of Labor Statistics, and we apply 2009 federal poverty guidelines for the 48 contiguous states available online at: http://aspe.hhs.gov/poverty/09poverty.shtml. We follow the methodology of the Kaiser Family Foundation that uses these income criteria to select the population eligible to purchase insurance through an Exchange (Trish et al., 2011). Adults and children in households with lower incomes are deemed to qualify for Medicaid. We do not simulate employer behavior as does the CBO model (CBO, 2011).

[16] Small employers are either (1) those with fewer than 50 employees or (2) those with fewer than 100 employees and who report only one business location. The ACA states that individuals whose out-of-pocket premiums for employer-sponsored insurance exceed 9.5% of family income will be eligible to purchase health insurance through an Exchange. A write-up of the details of our data selection algorithms in MEPS to select our Exchange population is available from the authors upon request.

[17] Most people contribute two years of data. If someone dies in the first year, they would contribute just one. We used no additional weighting of observations.

4.2 Silver and Gold Plan Costs

The ACA allows for four plan levels, Bronze, Silver, Gold and Platinum, (along with a high-deductible plan for young adults) distinguished by the "actuarial value" of coverage in each level.[18] All so-called Qualified Health Plans (QHPs) plans must cover a set of mandated benefits but are free to contract with networks of providers and to "manage" care. We assume two plan types, and exaggerate the difference between "Gold" and "Silver." Specifically, we assume the costs in a Gold plan are to 120% of costs in a Silver plan, making incremental costs equal to 20% of Silver plan costs for each person. In the empirical application, we use MEPS data to classify Exchange participants into ht groups, and then assign the average costs within the group as Silver plan costs. We inflate the costs for each ht group by 20% to assign Gold Plan costs.

4.3 Plan Revenues

The ACA specifies that premiums be based on age (with regulated rate bands), smoking status, geography, and family size, but not on pre-existing conditions, gender, or other factors.[19] We set three age categories, young adult (19-30), middle-age adult (31-50) and older adult (51-64), and four geographic areas, the four census regions (to mimic geographic areas within a state). We thus have 12 (3x4) premium categories for which we will study the incremental premium between Gold and Silver plans. We do not use smoking status because this variable, conditional on age, is weakly associated with health care costs in the Exchange population.[20] For purposes of this analysis, we treat couples as two individuals. Rate-band regulation applies to the total premium at plans, not the incremental premiums. After risk adjustment our equilibrium premiums satisfy ACA rate-band restrictions.[21]

We risk adjust with the Hierarchical Condition Category (HCC) model recommended for Exchanges by CMS (Department of Health and Human Services 2013). A simpler version of

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[18] Actuarial value in the ACA is the share of covered costs paid by the plan. Bronze Plans have an actuarial value of .6, Silver, .7, Gold, .8 and Platinum, .9. Deductibles and copayments/coinsurance determine the actuarial value.

[19] CMS has recently recommended a particular age-profile to be used in premiums, though states are free to set their own subject to the maximum 3-1 ratio between old and young (Department of Health and Human Services, 2013).

[20] We found this in our earlier paper on premiums and risk adjustment with these data (McGuire et al., forthcoming). Smoking status is problematic also from the standpoint of accurate reporting.

[21] Our premium analyses ignore the temporary reinsurance features of Exchanges. In the first three years of Exchanges, plans will be forced to participate in a federally run system of reinsurance in which the "attachment point" where reinsurance kicks in is set at $60,000. Plans are responsible for only 20% of costs after this point. Reinsurance could be incorporated by refiguring plan net costs with this feature as we have done in other research (Zhu et al., 2013).

this model pays private drug and managed care plans in Medicare. The Exchange version maps diagnoses from ICD-9 codes from claims into one of 100 HCCs. Diseases within an HCC are similar clinically. Each individual is given a (0,1) indicator for each HCC, and these become part of a linear regression model with individual demographics and some disease interactions to predict cost. The coefficients from this model are the "weights" on age, gender, HCC and other factors used in risk adjustment (Pope et al., 2011). We use the same age categories for risk adjustment as the CMS-HCC model. Our goal is to find the best weights on the elements going into the CMS risk adjustment model.

Notably, CMS recommends that the HCC model for Exchanges be *concurrent*, using this year's medical events to determine the risk-adjusted payment for this year. This is in contrast to its use in Medicare, and virtually all other formal risk adjustment systems, where the model is *prospective*, using last year's medical experience to predict this year's costs. We follow CMS recommended practice and use concurrent risk adjustment here.[22]

Our risk adjustment model diverges from the CMS recommendation in several ways to accommodate the MEPS data. First, whereas the CMS-HCC model uses 5-digit ICD-9 diagnosis code to classify diagnoses, the MEPS public use files do not include 5-digit ICD-9 codes. We use the 3-digit ICD-9 codes which are publicly available.[23] Documentation of the CMS-HCC model indicates that moving from 3 to 5-digit classification does little to improve model fit in MEPS.[24] In MEPS, diagnostic data come from household reports which lack the specificity and precision of physician reports (AHRQ 2011). Second, we do not include the full set of HCC indicators because of limitations of our sample size, nor do we include interaction effects for the same reason. The 58 HCCs with more than 20 observations are entered in the model. The remaining 9 HCCs appearing in the data with a total of 73 observations are aggregated into a

[22] Concurrent risk adjustment has two things going for it: first, it doesn't require data from a previous year to figure; and second, it will do a much better job of fitting plan costs than prospective risk adjustment. The main problem with concurrent risk adjustment is that it weakens incentives for plans to contain costs (Van de ven and Ellis, 2000). Medicare has a version of the same problem as Exchanges of how to pay for the "new" beneficiaries without a prior year of experience. For these new beneficiaries they use a simplified age-gender risk adjustment model. Exchanges could do the same.
[23] In our model we assume that the 3-digit code we observe in the data corresponds to the smallest ICD-9 code that starts with those three digits. For example, an ICD-9 code of 003 in MEPS is assumed to represent 0031, which is the smallest code within the 003 category.
[24] MEPS documentation states: "DxCG Inc. staff have examined how using 3-digit diagnoses (rather than 5-digit codes) would affect the prospective DCG/HCC model's performance. They concluded that, although using 3-digit codes would reduce the model's specificity in clinical classification and its predictive accuracy, the loss in specificity and predictive power was small." (AHRQ 2008, page C-2).

single category.   HCC classifications HCC108 (Chronic Obstructive Pulmonary Disease) and HCC 176 (Artificial Openings for Feeding and Elimination) are too inclusive with our 3-digit classification, so broke these into finer categories. We also added HCCs for pregnancy. The exact algorithm we used to modify the HCCs is described in Table A in the Appendix. We will refer to the risk adjustment system we use as CMS-HCCs, even though we modified it in the ways just described. Risk-adjustment regressions (conventional and constrained) are represented in Table B of the Appendix.

4.4 Demand for Gold Plan and Efficiency of Sorting

We specify demand and efficiency in ways that can be operationalized empirically. Our assumptions respect important economic properties: first best is attained with full information and incremental premiums equal to incremental costs for all persons; no selection emerges when everyone has the same expectation about their health care costs; and, with limited premium discrimination, individuals' more accurate forecasting of their own costs increases selection.

Demand for the Gold plan depends on the benefits a person *expects to get* in Gold over Silver, and on the incremental *premium*. Efficiency depends on the added benefits a person *actually gets* in a plan, and on the incremental *cost*. We start with efficiency and assume the incremental benefit a person i of type ht gets in the Gold Plan, b_{iht}, has two components, both measured in dollars.

$b_{iht} = \beta x_{ht} + v_i,$ $\beta > 1$, $v_i \sim$ uniform $[v_{min}, v_{max}]$

The first component of benefit is the value of incremental services type ht gets in the Gold Plan, βx_{ht}, common to all members of group ht. In what follows we assume that all individuals share the same β. When $\beta>1$, these services are valued at more than cost (cost = 1). (β could also be less than one.) Second is an idiosyncratic component of benefit that differs by person, v_i, which captures idiosyncratic valuation of the incremental services, risk aversion, taste for plan management styles and other factors. We assume for simplicity, that v_i, is uniformly distributed between a minimum and maximum value, but the range $[v_{min}, v_{max}]$ depends on t.

For efficiency, a person should be in the Gold Plan if and only if the incremental benefits of Gold exceed the incremental costs. Incremental costs in Gold are x_{ht} so the rule for efficiency is that individual i should be in Gold iff:

$\beta x_{ht} + v_i - x_{ht} > 0$ $\hspace{4cm}$ (6)

In relation to the first-best, the welfare loss in any equilibrium is the lost benefits for those in the "wrong" plan. Generally, for a person in Silver when (6) is positive, the loss is $\beta x_{ht} + v_i - x_{ht}$; for a person in Gold when (6) is negative, the loss is $-(\beta x_{ht} + v_i - x_{ht})$.

Turning to demand, we specify what individuals expect in terms of incremental benefits at the Gold Plan. Selection on the basis of health costs depends on individuals' ability to forecast their health care demand.[25] Better forecasting aggravates selection incentives. We assume a person of type ht expects the following incremental services in the Gold plan:

$$x_{ht}^e = \gamma x_{ht} + (1 - \gamma)\bar{x}$$

Individuals' expectations of their added services are a weighted average of their ht-group incremental cost, $x_{ht,}$ and the population average, $\bar{x}$. The weight, γ, on ht-group specific spending in expectations could differ by person, but for simplicity we assume all persons share the same ability to predict. The case of "no selection" corresponds to $\gamma = 0$; when $\gamma = 1$, individuals fully anticipate their incremental services in the Gold Plan. We operationalize x_{ht} by the predicted values from a regression using all the h-variables from the CMS-HCC model as well as the t-variables used to define premiums. This regression is reported in Table B of the Appendix.

Recalling that p_t is the incremental premium charged to a person of type t in a Gold plan, an individual i chooses Gold iff:

$$\beta x_{ht}^e + v_i - p_t > 0. \tag{7}$$

The (7) rule can be aggregated to define demand curves for Gold Plan membership. Assuming an interior solution (i.e., the premium p_t is such that some individuals choose the Gold plan and some choose the Silver plan) demand for membership in Gold for one ht group is

$$N_{ht}^g = \frac{v_{max} - [p_t - \beta x_{ht}^e]}{v_{max} - v_{min}} N_{ht} \tag{8}$$

The nature of selection and efficiency in our EF-type model can be illustrated with demand curves for two h groups of the same size with the same t and therefore facing the same premium. See Figure 3. We let h take the values 1 and 2 and call the groups 1t and 2t, with costs higher for group 1t. Demands for Gold for each group (from (8)) will be linear, with a

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[25] Selection could also arise based on another factor correlated with health care costs. Correlation with "other factors" is why in some settings researchers observe favorable selection. (See, e.g., Cutler, Lincoln and Zeckhauser, 2010) For example, if risk aversion is inversely related to health care costs, more generous plans will experience favorable selection. Here we set v_i, representing "other factors," to be independent of health care costs so no such correlations are introduced.

slope of $\frac{-1}{v_{max}-v_{min}} N_{ht}$, (which, in this example is identical to both types). The intersection on the vertical axis will be where $p_t = v_{max} + \beta x_{ht}^e$, taking a value higher for the higher demand group. Since expectations of health care use are imperfect, actual benefits will diverge from expected benefits (demand). Suppose groups 1t and 2t both underestimate what their actual incremental use in the Gold plan. Benefits are also shown in Figure 3. Finally, Figure 3 contains the incremental costs for the two groups, equal to x_{1t} and x_{2t} respectively, and the efficient memberships in Gold, N_{1t}^{g*} and N_{2t}^{g*}.

We make several observations based on the Figure. First, for any premium p_t which the two h groups have in common, more members of the more expensive group 1t will join Gold than the equal-sized less expensive group 2t, i.e., selection happens. Indeed, until the premium falls to $v_{max} + \beta x_{2t}^e$, only group 1t will join. With further premium reductions, some of both Groups join Gold. Since in our model both demands have slope of $\frac{-1}{v_{max}-v_{min}} N_{ht}$, at the margin the mix of joiners is 50-50, reflecting the overall mix in the t category. As premium falls, the composition of the Gold joiners will move towards the mix of h groups in the t category, reducing the degree of selection. (This is consistent with the EF model.)

Second and importantly, no single premium will lead both groups to make the efficient decision about Gold membership. In other words, no premium can induce N_{1t}^{g*} to join Gold from 1t and N_{2t}^{g*} to join Gold from 2t. This illustrates that the best premium for a t group is a second best – full efficiency is plan sorting is unattainable with a single premium.

Third, the "first-best" premium for each of the two groups is not incremental marginal cost, when demand diverges from benefit. Take group 1t. We want N_{1t}^{g*} from this group to join Gold. Setting a premium for this group to be equal to x_{1t} would not do it – too few would join Gold at that premium because health care costs are anticipated imperfectly. We have to reduce the incremental premium to below this level to "correct for" the underanticipation of health care costs among members of a high-cost group.[26] Recognizing imperfect foresight implies that a Pigouvian correction for under or overanticipation of benefits needs to be built into the second-best premium.

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[26] If we could set premium separately for group 1t (which of course we cannot), it would be $p_{1t}^* = x_{1t} + \beta(x_{1t}^e - x_{1t})$. The correction for imperfect foresight is the $\beta(x_{1t}^e - x_{1t})$ term.

5. Results

We begin with two normative benchmarks: the (unattainable) first best in which everyone is in the best plan for them, and the (attainable) second best in which the Gold incremental premiums for each of the 12 premium categories are chosen so as to minimize welfare loss in sorting.

To implement these benchmarks we need to make choices about the parameters describing benefits and demand. We choose parameter values for β, v and γ to lead to what we judge to be a reasonable degree of adverse selection between the two plan types (described shortly). In EF terms, that the incremental AC for the Gold plan is declining with lower premiums (selection happens), and cuts the demand curve from below (there is an equilibrium, no "death spiral."). In other words, the market demand and cost curves look something like Figure 1 above from the Einav, Finkelstein and Cullen (2010) paper.

5.1 Benchmark: First-Best Allocation

Table 2 describes the first-best sorting of individuals between Silver and Gold plans for a baseline set of parameter values. We set $\beta = 1.1$. The idiosyncratic term v is uniform with three ranges, one for each of the three age groups. For the young, v is [-$1,000, $1,000], for the middle-aged group [-$2,000, $2,000] and for the older group [-$4,000, $4,000], ranges roughly scaled to health care costs for the three age groups. On average, the additional services in Gold are worth their cost (since $\beta > 1$) but not for everyone because of the idiosyncratic term. For the first-best, we use rule (6) to allocate membership from each ht group to the Gold plan. All persons in an ht group are the same except for their idiosyncratic v term. We can define a cutoff value of v for each ht group that defines the person whose net benefit is the same in the two plans. From (6):

$$v_{ht}^* = (1 - \beta)x_{ht}$$

Persons in an ht group with $v_i \geq v_{ht}^*$ should be in Gold; others in Silver. When $\beta > 1$, v_{ht}^* is negative, indicating that more than half of members of all ht groups will be in Gold in the first-best.

The number of persons in an ht group who should go to the Gold plan, N_{ht}^{g*}, is simply the number in the group times share whose valuation exceeds x_{ht}, the incremental cost, or

$$N_{ht}^{g*} = N_{ht}\left[\frac{v_{max} - v_{ht}^*}{v_{max} - v_{min}}\right]$$

N_{ht}^{g*} has a maximum value of N_{ht} and a minimum of 0. Summing over h yields the values for each t group in Table 2. Table 2 also shows the average costs for the enrollees in the two plans for each premium group.

5.2 Benchmark: Second-Best Allocation

The second normative standard is a second-best in which demands, conditioned on premiums in 12 categories, determine the allocation of people between Gold and Silver Plans. One consideration in the second best is the incremental cost of Gold for a premium group. "Incremental" refers to the cost of Gold above Silver. As (3) makes clear, as the incremental premium changes, a mix of heterogeneous individuals within the t group change plans. "Incremental cost" in this context is thus the weighted average of the incremental costs of persons choosing Gold as a function of the premium. Because there is a mix of types on the margin within a premium group, the second-best incremental premium will not be the "right" premium for each of the h-groups involved.

A second consideration is the distinction between demand and benefit. Generally, with imperfect foresight, individuals will not accurately predict their health care costs, and therefore not accurately predict how much they would benefit from membership in the Gold plan. In our simulations we assume $\gamma = .2$, implying that individuals put .2 weight on the actual costs of their ht group with forming expectations and .8 weight on the sample mean, $\bar{x}$.[27] The second-best incremental premium is defined by the intersection of the marginal benefit schedule for a t group and marginal costs.

To find the second-best allocation and premium, we trace out demand, marginal benefit and (averaged) incremental marginal cost curves for each premium group and find their intersection, a process illustrated in Table 3 for the 31-50 year olds in the Northeast. Beginning at the bottom of the table with a high premium of $1500, enrollment in Gold is 1,138 out of the 4,167 people in that premium group. The table also shows costs for both plans at this premium. For those in the Gold plan at this premium the average cost is $3,869, and $2,725 for the balance of the people in the Silver plan. Costs differ because for any person the Gold is 20% more expensive, and because a different mix of people (h-types) are in the two plans. Note that as the

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[27] Some researchers (e.g., Newhouse et al., 1989) have argued that about 25% of health care costs are predictable by individuals. We acknowledge, however, that we choose γ for practical reasons, to make the degree of selection look "reasonable."

premium falls, more people move to Gold, but also the Gold average cost falls. The most expensive h-types within the premium group prefer the Gold at the high premium, but as the premium falls, a more representative group is joining. As the last column, incremental marginal cost indicates, the mix of h-types joining the Gold plan is constant over this range of premiums.[28] (At premiums much higher or lower this would not be true.) "Incremental average cost" refers to the difference in the average cost at the Gold and the Silver plan. This falls as premium falls. In a market equilibrium, this incremental average cost needs to be covered by the incremental premium (above a premium at the Silver plan that covers average cost) at the Gold plan.

The marginal benefit schedule is constructed as follows. As incremental premium falls, we know (by demand which depends on x_{ht}^e) which individuals move to the Gold plan. These individuals have a benefit (which depends on x_{ht}) from the Gold plan. The marginal benefit value in Table 3 is these benefits averaged over the people who move for a given premium difference. Figure 4 plots demand, marginal benefit, incremental average and marginal cost from Table 3. Because marginal benefit is below demand, to induce the correct enrollment, the incremental premium charged to this group must be less than incremental marginal cost.

Table 4 shows the second-best enrollment and premiums for all 12 premium groups. Enrollments are in all cases very close to the enrollments in the first-best. Seeing 1305 in Gold in both the first and second best does not mean the second best is identical to the first best. The 1305 is rounded to the nearest whole person, but more importantly, there are some wrong assignments both ways in the second best, whereas everyone is in the right plan for them in the first-best scenario. Specifically, for the 19-30 year olds in the NE, 16 enrollees (1.3 percent of Silver enrollment) are in Silver who should be in Gold and 16 in Gold who should be in Silver. For the entire population, 359 are in Gold who should be in Silver and 358 are in Silver who should be in Gold, amounting to slightly over 1 percent of the population.[29]

The last column in Table 4 shows the average welfare loss per person for each group and overall associated with being in the "wrong" plan. In the first best, everyone in an ht group with a value of $v > v_{ht}^*$ should is in Gold. By contrast, in the second best, where individuals respond to a premium, although that premium is set at the most efficient level for the t group, it will not be efficient for each of the h groups within the premium category. In the second-best, everyone

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[28] This special feature is a consequence of our assumptions.
[29] These numbers are not shown in the Table, and are rounded to the nearest "whole person."

with a $v > v_{ht}^{2nd-best}$ will choose Gold where this cutoff for each ht group in the second-best where

$$v_{ht}^{2nd-best} = p_t^{2nd-best} - \beta x_{ht}^e$$

Thus, within each ht group there is a range of individuals between v_{ht}^* and $v_{ht}^{2nd-best}$ who are in the "wrong" plan. For some h groups $v_{ht}^* > v_{ht}^{2nd-best}$ and for others the reverse will be true. To see how we calculate welfare loss for each h group, suppose for some group $v_{ht}^* > v_{ht}^{2nd-best}$ implying that too few people from this group are in the Gold plan. The measure of inefficiency for this h group is the probability that someone in the group is in the wrong plan times the average lost benefit for the person wrongly located.

Avg Welfare Loss for ht group in Second-Best $= \left[\frac{v_{ht}^* - v_{ht}^{2nd-best}}{v_{max} - v_{min}}\right]\left[\frac{v_{ht}^* - v_{ht}^{2nd-best}}{2}\right]$

The first term of this product is the probability that a person is in the range of v where the person is in the wrong plan; the second term is the average of the lowest (0) and highest (v_{ht}^* - $v_{ht}^{2nd-best}$) value of the net benefit lost from being in the wrong plan.[30]

Averaged over the entire population this comes out to only $.70 per person, the minimum welfare loss that can be attained given these premium groups. The welfare loss in the second best also depends on the benefits in the two plan types and on the nature of individuals' expectations about their costs. The adverse selection problem would be aggravated, and the welfare loss higher, if individuals could forecast more accurately than we have assumed here in these simulations.

The second-best allocation depends only on the incremental premium charged enrollees for Gold. Silver and Gold plans must of course break even in an equilibrium. This consideration introduces another set of factors that will determine how much more people are charged to join Gold: the difference between the break-even premium for the Silver plan and for the Gold plan. This will not, of course, in general, be the second best. We move now to consideration of a series of market equilibria: no risk adjustment, conventional risk adjustment, and risk adjustment to hit the second-best premiums. In all equilibria considered, premium for each category for the Silver and Gold plans will be equal to average cost in that premium category.

5.3 Equilibrium with no Risk Adjustment

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[30] Thus, a kind of "Harberger triangle."

In equilibrium, premium for the Silver plan must equal Silver Plan average costs, premium for the Gold plan equals Gold plan average costs, and the difference between these, the incremental premium that consumers face, must sort individuals such that the resulting plan average costs are covered by the premiums. We find the equilibrium by tracing out demand and cost curves.

The equilibrium is depicted graphically in Figure 5 for the 31-50 year olds in the Northeast. Figure 5 augments Figure 4 with a lower quadrant showing the average costs for both plans.[31] The incremental average cost in the upper quadrant is seen to be the difference between the average cost curves from the lower quadrant. The lower quadrants can also be used to depict the equilibrium premiums in both the Gold and Silver Plans.

Results are summarized for all twelve premium categories in Table 5. Fewer enrollees are in Gold because for all premium categories, premiums to cover average costs are "too high" in relation to either the first or second best. Instead of more than half of people in Gold in the second best, only 40 percent (26,044/64,667) are in Gold in the equilibrium without risk adjustment. Note that as in the second-best, there will be enrollment mistakes in both directions, though with equilibrium premiums too high, most of the mistakes will be putting too many people in Silver. The welfare loss in this equilibrium is much greater than the second best. On average, as the last column in Table 5 shows, the welfare loss is $32.25 per person.

Beginning with this first equilibrium, we can keep track of how well the payment system – here just premiums – fits costs for Gold and Silver plans. By "fit" we mean the degree to which variation in revenue per person tracks costs per person. To figure fit we generalize the concept of statistical fit to account for both premiums and risk adjustment of plan payments. For each individual, we construct a measure of total payments to the plan (i.e. plan revenues), including the premium and risk adjustment. This value is then compared with the individual's costs to construct our fit measure.[32] Specifically, let R_i be the total revenue a plan receives for person i after risk adjustment, and x_i be the total costs for person i. Total variation in Silver plan

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[31] In the textbook EF model, the "other plan" has zero costs and zero premium for any enrollee. When the other plan is a real plan, its costs too will vary as enrollment changes in the Gold Plan.

[32] There are other plausible measures of fit, such as the mean absolute difference between revenues and costs. Not squaring this difference down weights the influence of high-cost outliers in the fit measure. We chose the payment system R-squared to be easily comparable to statistics reported for risk adjustment, and on the general principle in economics that the economic value of a loss goes up approximately with the square of the difference between the actual and the optimal price.

costs is $\sum_i(x_i^S - \overline{x^S})^2$, where $\overline{x^S}$ is the mean plan cost and the summation is over individuals in the Silver plan. Variation remaining after the payment system is $\sum_i(x_i^S - R_i)^2$. Thus, the R-squared or "fit" of the payment system for Silver is

$$\text{Payment system fit for Silver} = 1 - \frac{\sum_i(x_i^S - R_i)^2}{\sum_i(x_i^S - \overline{x^S})^2}$$

A similar expression characterizes fit in the Gold plan.

Plan revenues in the current simulation are simply the premiums covering average cost for each premium group. Some "risk adjustment" is accomplished by premium categories. Values for payment system fit are 0.019 for both Silver and Gold in the no risk adjustment case.

5.4 Equilibrium with Conventional Risk Adjustment

Conventional risk adjustment is based on the regression from Table B. Conventional risk adjustment is estimated *ex ante*, before plans set premiums and before individuals choose plans. The demand curve for Gold membership is unaffected by risk adjustment. Risk adjustment affects the costs that must be covered by premiums at the two plans because the risk adjusted revenues now vary according to the personal characteristics of the joiners. Therefore, the incremental average cost that describes the difference in the premiums for Gold and Silver for any premium group also changes. Risk adjustment takes from each plan (either Gold or Silver) the average cost at the Silver plan, $\overline{x}^S$, and returns to each plan the risk-adjusted payment r_h estimate from a regression on Silver plan costs (from Table B in Appendix). (This risk adjustment system is self-financing but the amount "taken" from the plans does not affect the equilibrium so long as the amount is constant for both plan types – it only affects the level of premiums in the two plans.) We compute average cost at the Gold and Silver plans net of risk adjustment transfers then the average incremental cost for the Gold Plan. Equilibrium is, as before, where the incremental premium at the Gold Plan equals this risk-adjusted average incremental cost.

Concurrent conventional risk adjustment imposes the market equilibrium compared to that with no risk adjustment, as shown in Table 6. Equilibrium premiums are much reduced, and many more people move to Gold. This is consistent with the objective of risk adjustment: by transferring funds to more costly individuals, selection has less effect on the net average cost of the plans. (If risk adjustment were perfect and fully picked up expected costs, the mix of joiners would have no effect at all on plans' average costs.) Incremental premiums for the young groups

are below the second best premiums, and for the older groups they are above. Risk adjustment can deal with correcting premiums for selection; it cannot deal at all, at least directly, with correcting for over or underanticipation of costs. The welfare loss per person in conventional risk adjustment falls to $6.32 per person.

Furthermore, conventional risk adjustment improves the fit of the payment system for both plans. For the Silver plans the payment system fit rises to .168 and to .164 for the Gold plans.

5.5 Risk Adjustment to Achieve the Second Best

In our final set of simulations, we find risk adjustment weights incorporating constraints to ensure that the equilibrium premium is the second-best incremental premium. Consider the first premium group, the 19-30 year olds living in the Northeast. Call them premium group 1. With conventional risk adjustment, Table 6 tells us that the equilibrium incremental premium is too low, $298 instead of the second-best $499, and too many from this group are in the Gold plan in the conventional risk adjustment equilibrium. The constraint that premium for the 19-30 year olds in the NE is $499 in equilibrium comes from the expressions that the Silver and Gold plan premiums for this group must be zero profit. For the Silver plan, premium for group 1 is the cost for the group less the net risk adjustment transfer:

$$p_1^s = \frac{\sum_h N_{h1}^s x_{h1}^s}{\sum_h N_{h1}^s} - \frac{\sum_h r_h N_{h1}^s}{\sum_h N_{h1}^s} + \bar{x} \qquad (9)$$

Expressing the Gold premium as the Silver premium +$499 (the desired incremental premium), the breakeven condition for the Gold plan for group 1 is:

$$p_1^s + 499 = \frac{\sum_h N_{h1}^g x_{h1}^g}{\sum_h N_{h1}^g} - \frac{\sum_h r_h N_{h1}^g}{\sum_h N_{h1}^g} + \bar{x} \qquad (10)$$

Substituting for the Silver premium and cancelling the overall average costs, we have:

$$499 = \frac{\sum_h N_{h1}^g x_{h1}^g}{\sum_h N_{h1}^g} - \frac{\sum_h N_{h1}^s x_{h1}^s}{\sum_h N_{h1}^s} + \frac{\sum_h r_h N_{h1}^s}{\sum_h N_{h1}^s} - \frac{\sum_h r_h N_{h1}^g}{\sum_h N_{h1}^g} \qquad (11)$$

The $499 has to cover the difference in the average costs between the two plans (the first two terms in (11), less any higher risk adjustment transfers to Gold.

Having solved for the second best, we know average cost in the Silver and Gold plan in the second best, and the enrollments in those plans in the second best. The only "variables" in (11) are the risk-adjustment weights. Thus, (11) is linear in the r_h weights, and forms the

constraint corresponding to the restriction that the incremental premium for the 19-30 year olds is the second best in equilibrium.

After reproducing the conventional risk adjustment equilibrium results in the first pair of columns, Table 7, in the second pair of columns, shows the equilibrium with a risk adjustment system estimated by imposing the one constraint, (11) from above. Specifically, we estimate a conventional concurrent risk adjustment model, identical to the one contained in Table B from the Appendix B and described above, but with the constraint that the risk adjustment weights satisfy (11). This regression, and the regressions with more constraints are also contained in Table B. With new risk adjustment weights, there will be a new equilibrium for all premium categories. Table 7 shows the full set of results. Equilibrium incremental premiums generally move in the right direction (towards the second best) for all the young premium categories as the result of imposing the single constraint for the young NE group. The welfare cost per person for all four of the young groups fall as this one constraint comes into play. In aggregate, the sorting between Gold and Silver becomes more efficient, with the per person welfare loss dropping from $6.32 to $4.75 per person.[33]

Improvement in sorting efficiency comes at a cost in terms of "fit" of the payment system to the Gold and Silver plan. With one constraint, the payment system fit in the Silver and Gold plans fall from 0.168 and 0.164 with conventional risk adjustment to 0.155 and 0.149, respectively. Fit statistics are summarized for our equilibrium cases in Figure 6.

Table 7 and Figure 6 also contain the results for risk adjustment systems in which we include two and three constraints. Our two-constraint model imposes, in addition to (11) above, a constraint that the premium for the 31-50 year olds in the NE must be equal to $535, the second-best incremental premium for this group. The form of the constraint is analogous to (11). Welfare loss from sorting falls for the middle groups and for the overall average for the population to $3.24. Fit deteriorates for both the Silver and Gold Plans. Finally, we also impose a constraint on the 51-64 year olds in the NE, making three constraints in total, bringing down welfare loss to $2.17 per person but leading to payment system fits for the Silver and Gold plans of 0.081 and 0.117, respectively.

In principle, we could impose more than three constraints on the second-best premium. To attain the full second best, we could impose all 12 premium constraints. In fact we have done

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[33] Because we are imposing just one constraint, there is no guarantee that the average welfare loss falls.

this in results not reported. We found that the constrained risk adjustment regressions yielded unreasonable coefficient estimates on the HCC indicators (i.e., too large or too small), and furthermore, the plan fit measures became very poor. We believe the instability and unreasonableness of the estimates would be relieved with a much larger sample size. In an Exchange population, a relatively small share of the population has any positive HCC indicator.[34] Calibration of the tradeoff between sorting efficiency and plan fit should be next done with the much larger data sets actually used for risk adjustment.

6. Discussion

A number of points will be covered in discussion:

- Purpose of paper is to develop and show how to implement a method; the actual tradeoffs quantified here are illustrative.
- How to make operational? With realistic information available to regulator, what are the practical implications?
- Relate to welfare frameworks where utilities are estimated as in Handel and Kostad, and Bundorf, Levin and Mahoney.
- Risk adjustment compression effect on premiums is helpful here, but depending on properties of demand and foresight, might aggravate rather than improve sorting.
- Method could be used to study the effect of changing the basis for premium setting (e.g., allowing premiums to vary by gender).
- Could incorporate other methods from McGuire et al 2013 which were set aside here for simplicity: augmented premium regression to find best fit, incorporation of other restrictions such as rate bands, recognition of no HCCs for part of population.
- Note our approach to robustness checks.

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[34] About 20% of the people in our Exchange population have any HCC.

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Table 1. Sample Demographic and Health Characteristics (N=64,667)

Age	
19-30	30.0%
31-50	46.1%
51-64	23.7%
Male	50.4%
Race	
White, non-Hispanic	50.3%
Black, non-Hispanic	13.7%
Hispanic	27.9%
Asian	5.7%
Other	2.2%
Education	
Less than high school	17.9%
High school	34.0%
Some college	17.4%
College degree	29.4%
Employment status[1]	
Continuously employed	74.6%
Continuously unemployed	11.7%
Household Income ($2010)	
Mean	$32,660
<$25,000	48.7%
$25,000-50,000	32.5%
$50,000-100,000	15.0%
>$100,000	3.5%
Geographic Region	
Northeast	14.0%
Mideast	19.4%
South	38.2%
West	28.3%
Insurance Status	
Uninsured	55.6%
Non-group	3.5%
ESI with employee premium> 9% of income	7.7%
Self-employed	0.5%
Small group ESI	32.5%
Health Care Spending (Mean, $2010)	$2,648
Self-reported Health Status	
Excellent	28.0%
Very good	32.1%
Good	28.5%
Fair	9.1%
Poor	2.0%

Source: Medical Expenditure Panel Survey (MEPS), 2004-2010.

Table 2. First-Best Allocation to Silver and Gold Plans

Age	Region	N	Silver	Gold	Silver	Gold
	Premium Categories		Average Costs		Enrollment	
19-30	Northeast	2,541	$1,273	$1,722	1,236	1,305
	Midwest	3,720	$1,797	$2,371	1,790	1,930
	South	7,298	$1,356	$1,820	3,544	3,754
	West	5,893	$1,119	$1,518	2,876	3,017
31-50	Northeast	4,167	$2,768	$3,538	2,024	2,143
	Midwest	5,703	$2,648	$3,452	2,773	2,930
	South	11,580	$2,112	$2,771	5,662	5,918
	West	8,406	$2,047	$2,630	4,114	4,292
51-64	Northeast	2,362	$4,474	$5,714	1,154	1,208
	Midwest	3,131	$5,024	$6,383	1,525	1,606
	South	5,826	$4,727	$5,990	2,842	2,984
	West	4,040	$4,012	$5,045	1,978	2,062

Table 3. Finding the Second-best Premium for the 31-50 Year Olds in the Northeast

Incremental Premium_Chosen	Enrollment in Gold	Silver	Gold	Incremental Average Cost	Incremental Marginal Benefit	Incremental Marginal Cost
		Average Costs				
$500	2,180	$2,653	$3,660	$1,007	$537	
$535	**2,143**	**$2,657**	**$3,664**	**$1,007**	**$572**	**$572**
$572	2,105	$2,661	$3,669	$1,008	$609	$572
$600	2,075	$2,664	$3,672	$1,008	$637	$572
$700	1,971	$2,673	$3,685	$1,012	$737	$572
$800	1,867	$2,681	$3,699	$1,017	$837	$572
$900	1,763	$2,689	$3,714	$1,025	$937	$572
$1,000	1,659	$2,696	$3,732	$1,036	$1,037	$572
$1,100	1,555	$2,703	$3,752	$1,049	$1,137	$572
$1,200	1,450	$2,709	$3,775	$1,066	$1,237	$572
$1,300	1,346	$2,715	$3,801	$1,087	$1,337	$572
$1,400	1,242	$2,720	$3,832	$1,112	$1,437	$572
$1,500	1,138	$2,725	$3,869	$1,144	$1,537	$572

Table 4. Second-Best Premiums and Allocation

Premium Categories			Enrollment		Incremental	Second Best	Welfare
Age	Region	N	Silver	Gold	Marginal Cost	Premium	Loss
19-30	Northeast	2,541	1236	1305	$271	$499	$0.57
	Midwest	3,720	1790	1930	$378	$512	$0.64
	South	7,298	3544	3754	$288	$501	$0.58
	West	5,893	2873	3020	$238	$494	$0.50
31-50	Northeast	4,167	2024	2143	$572	$535	$0.65
	Midwest	5,703	2773	2930	$553	$533	$0.82
	South	11,580	5663	5917	$443	$520	$0.71
	West	8,406	4113	4293	$424	$517	$0.52
51-64	Northeast	2,362	1154	1208	$924	$577	$1.03
	Midwest	3,131	1525	1606	$1,035	$591	$1.06
	South	5,826	2842	2984	$972	$583	$0.96
	West	4,040	1978	2062	$822	$565	$0.70
All		64,667	31,517	33,150	N/A	N/A	$0.70

Table 5. Equilibrium Premiums and Allocation without Risk Adjustment

Premium Categories			Enrollment		Premiums			Welfare
Age	Region	N	Silver	Gold	Silver	Gold	Incremental	Loss
19-30	Northeast	2,541	1,465	1,076	$1,202	$1,881	$679	$8.69
	Midwest	3,720	2,467	1,253	$1,742	$2,617	$876	$33.81
	South	7,298	4,245	3,053	$1,287	$1,980	$693	$9.80
	West	5,893	3,165	2,728	$1,046	$1,639	$593	$2.91
31-50	Northeast	4,167	2,551	1,616	$2,699	$3,740	$1,041	$32.65
	Midwest	5,703	3,684	2,019	$2,571	$3,743	$1,172	$51.90
	South	11,580	6,899	4,681	$2,030	$2,978	$947	$23.55
	West	8,406	4,666	3,740	$1,979	$2,758	$780	$9.14
51-64	Northeast	2,362	1,479	883	$4,370	$6,049	$1,679	$76.89
	Midwest	3,131	2,010	1,121	$4,923	$6,753	$1,830	$97.06
	South	5,826	3,635	2,191	$4,629	$6,300	$1,672	$75.06
	West	4,040	2,357	1,683	$3,927	$5,240	$1,314	$35.76
All		64,667	38,623	26,044	N/A	N/A	N/A	$32.25

Table 6. Equilibrium Premiums and Allocation with Conventional Risk Adjustment

Age	Region	N	Silver	Gold	Silver	Gold	Incremental	Welfare Loss
	Premium Categories		**Enrollment**		**Premiums**			**Welfare**
19-30	Northeast	2,541	981	1,560	$2,572	$2,870	$298	$10.58
	Midwest	3,720	1,602	2,118	$2,944	$3,355	$411	$3.17
	South	7,298	2,866	4,432	$2,595	$2,910	$315	$9.19
	West	5,893	2,190	3,703	$2,452	$2,714	$262	$14.01
31-50	Northeast	4,167	2,102	2,065	$3,074	$3,684	$610	$1.35
	Midwest	5,703	2,870	2,833	$2,842	$3,444	$601	$1.40
	South	11,580	5,553	6,027	$2,418	$2,900	$482	$0.89
	West	8,406	3,979	4,427	$2,582	$3,034	$453	$1.03
51-64	Northeast	2,362	1,276	1,086	$2,662	$3,652	$990	$11.67
	Midwest	3,131	1,726	1,405	$2,954	$4,058	$1,105	$17.60
	South	5,826	3,171	2,655	$2,673	$3,707	$1,034	$13.66
	West	4,040	2,130	1,910	$2,617	$3,482	$865	$6.32
All		64,667	30,446	34,221	N/A	N/A	N/A	$6.32

Table 7. Premium and Welfare Loss with Risk Adjustment with and without Constraints

Premium Categories		No Constraints		One Constraint		Two Constraints		Three Constraints	
Age	Region	Incremental Premium	Welfare Loss	Incremental Premium	Welfare Loss	Incremental Premium	Welfare Loss	Incremental Premium	Welfare Loss
19-30	Northeast	$298	$10.58	$499	$0.57	$499	$0.57	$499	$0.57
	Midwest	$411	$3.17	$611	$3.10	$590	$2.17	$643	$4.95
	South	$315	$9.19	$475	$0.75	$444	$1.39	$452	$1.17
	West	$262	$14.01	$411	$2.25	$384	$3.57	$407	$2.43
31-50	Northeast	$610	$1.35	$670	$2.92	$535	$0.65	$535	$0.65
	Midwest	$601	$1.40	$677	$3.42	$556	$0.89	$454	$1.59
	South	$482	$0.89	$550	$0.83	$443	$1.44	$367	$3.62
	West	$453	$1.03	$515	$0.52	$439	$1.28	$410	$1.96
51-64	Northeast	$990	$11.67	$1,049	$14.93	$904	$7.70	$577	$1.03
	Midwest	$1,105	$17.60	$1,165	$21.68	$1,034	$13.35	$746	$2.57
	South	$1,034	$13.66	$1,080	$16.39	$953	$9.51	$722	$2.16
	West	$865	$6.32	$902	$7.80	$813	$4.54	$642	$1.07
All		N/A	$6.32	N/A	$4.75	N/A	$3.24	N/A	$2.17

Note: "One constraint" sets incremental premium for 19-30 in Northeast to $499;

 "Two constraints" adds constraint that incremental premium for 31-50 in Northeast is $535;

 "Three constraints" adds constraint that incremental premium for 51-64 in Northeast is $577.

Figure 1. Efficiency Costs of Adverse Selection in Einav-Finkelstein Model
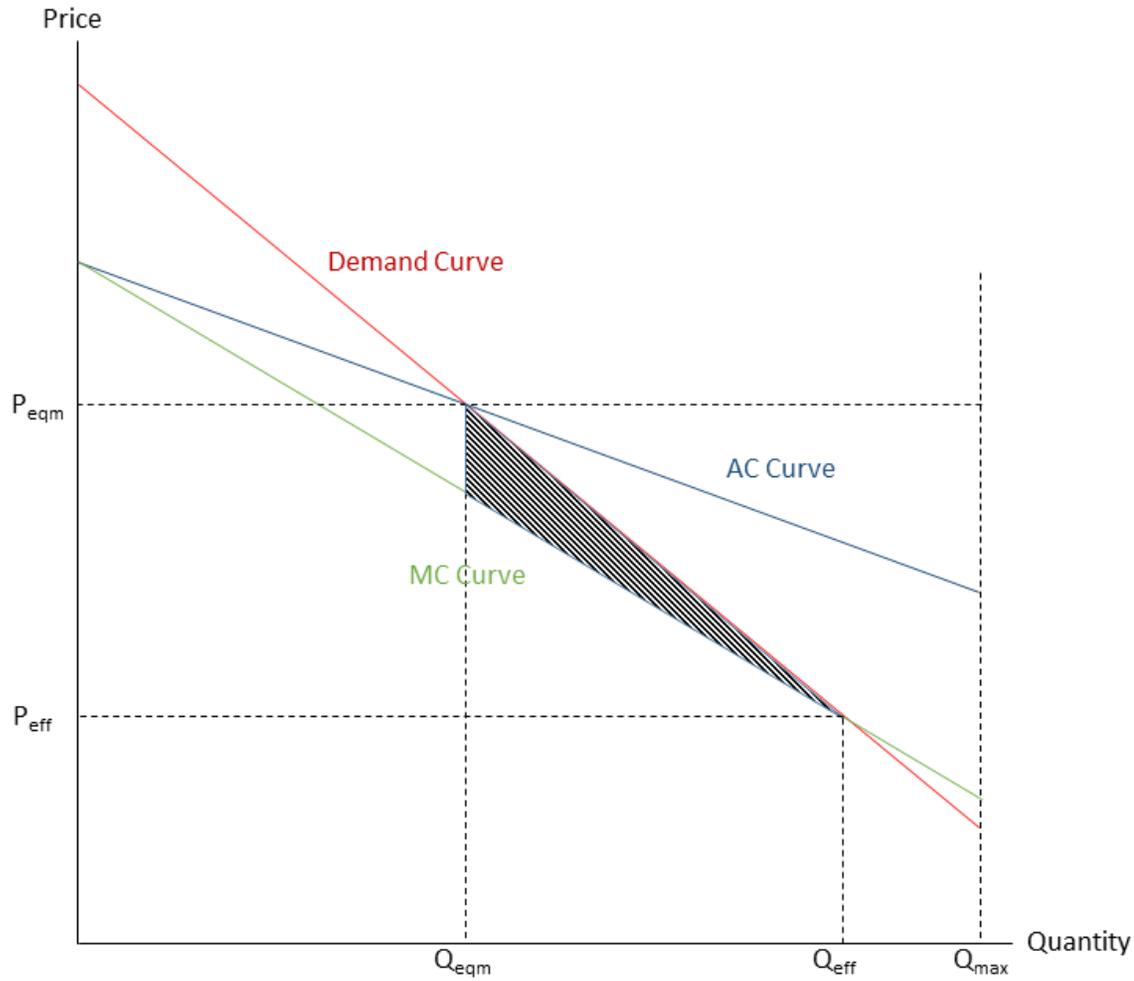
Source: Einav et al. (2010)

Figure 2. Welfare Loss with a Common Incremental Premium
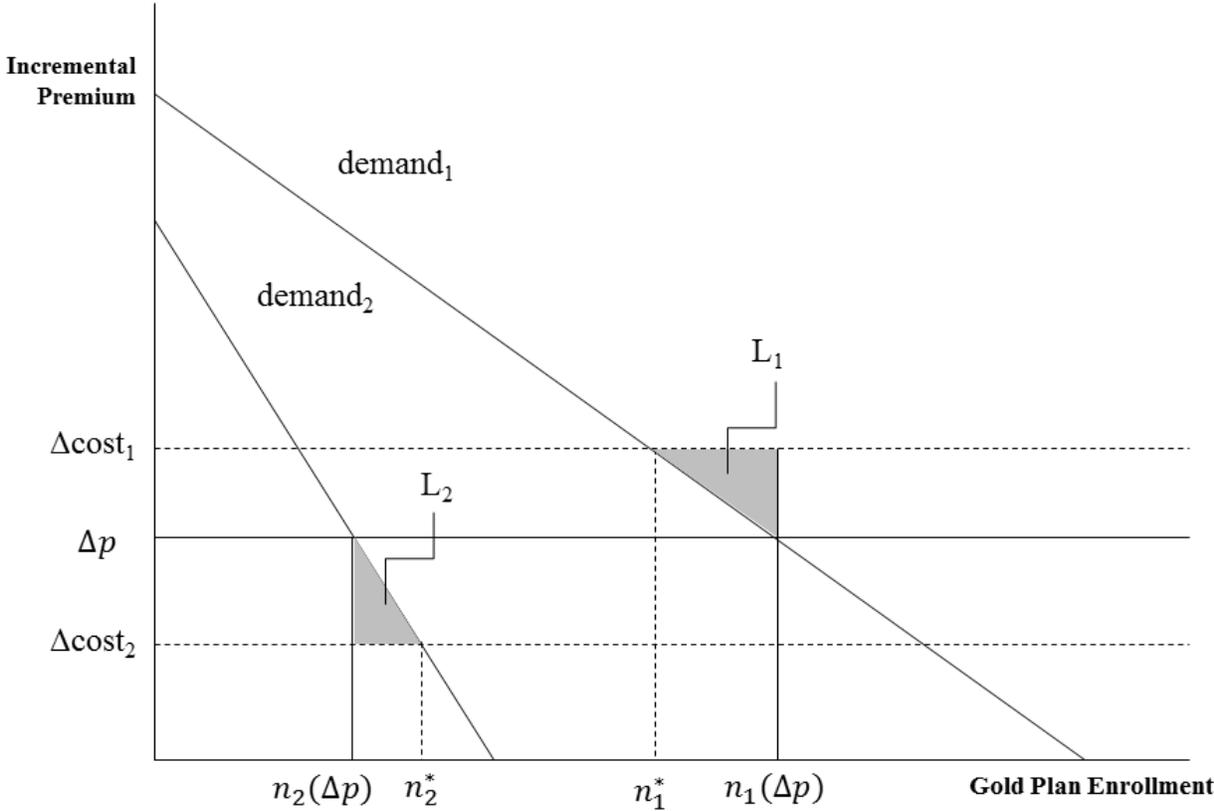
Figure 3. Demand and Benefit among Two Groups with Same Premium

Benefits,
Demand, Costs

$\beta x_{1t} + V_{max}$

$\beta x_{1t}^e + V_{max}$

$\beta x_{2t} + V_{max}$

$\beta x_{2t}^e + V_{max}$

Benefit group $1t$

Demand group $1t$

Benefit group $2t$

Demand group $2t$

Incremental costs, x_{1t}

Incremental costs, x_{2t}

Demand for Gold

N_{2t}^{G*} N_{1t}^{G*}
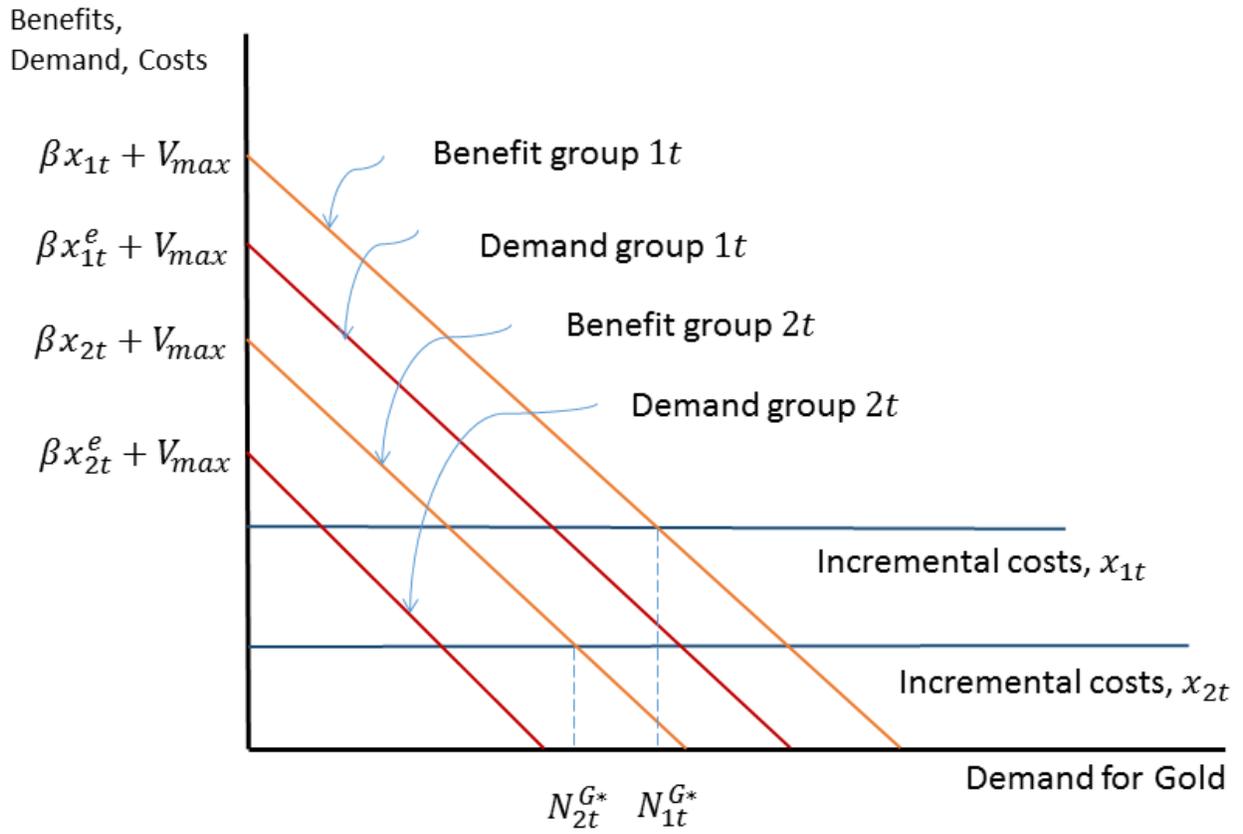
Figure 4. Second-best Allocation for 31-50 Year-olds, Northeast
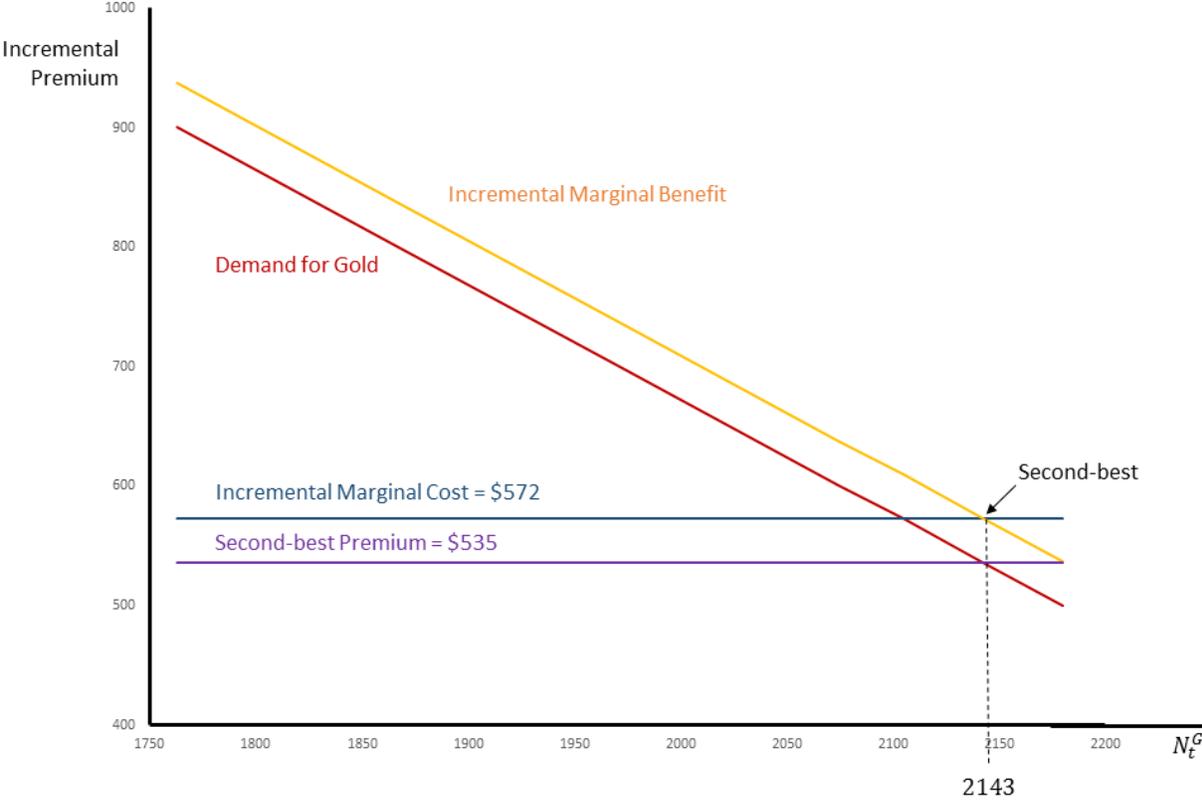
Figure 5. EF Equilibrium with No Risk Adjustment, 31-50 Year-olds, Northeast
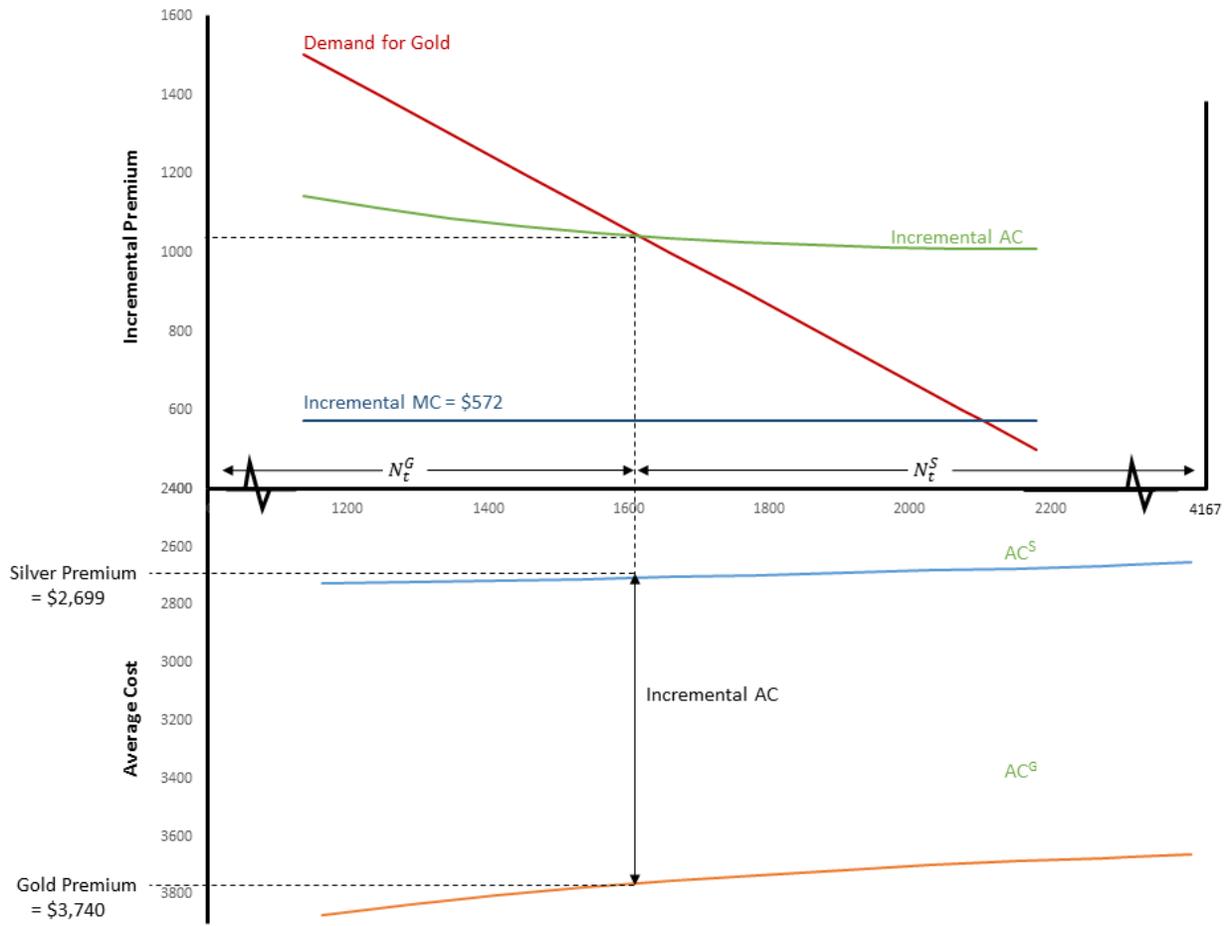
Figure 6. Payment System Fit and Sorting Efficiency Tradeoff
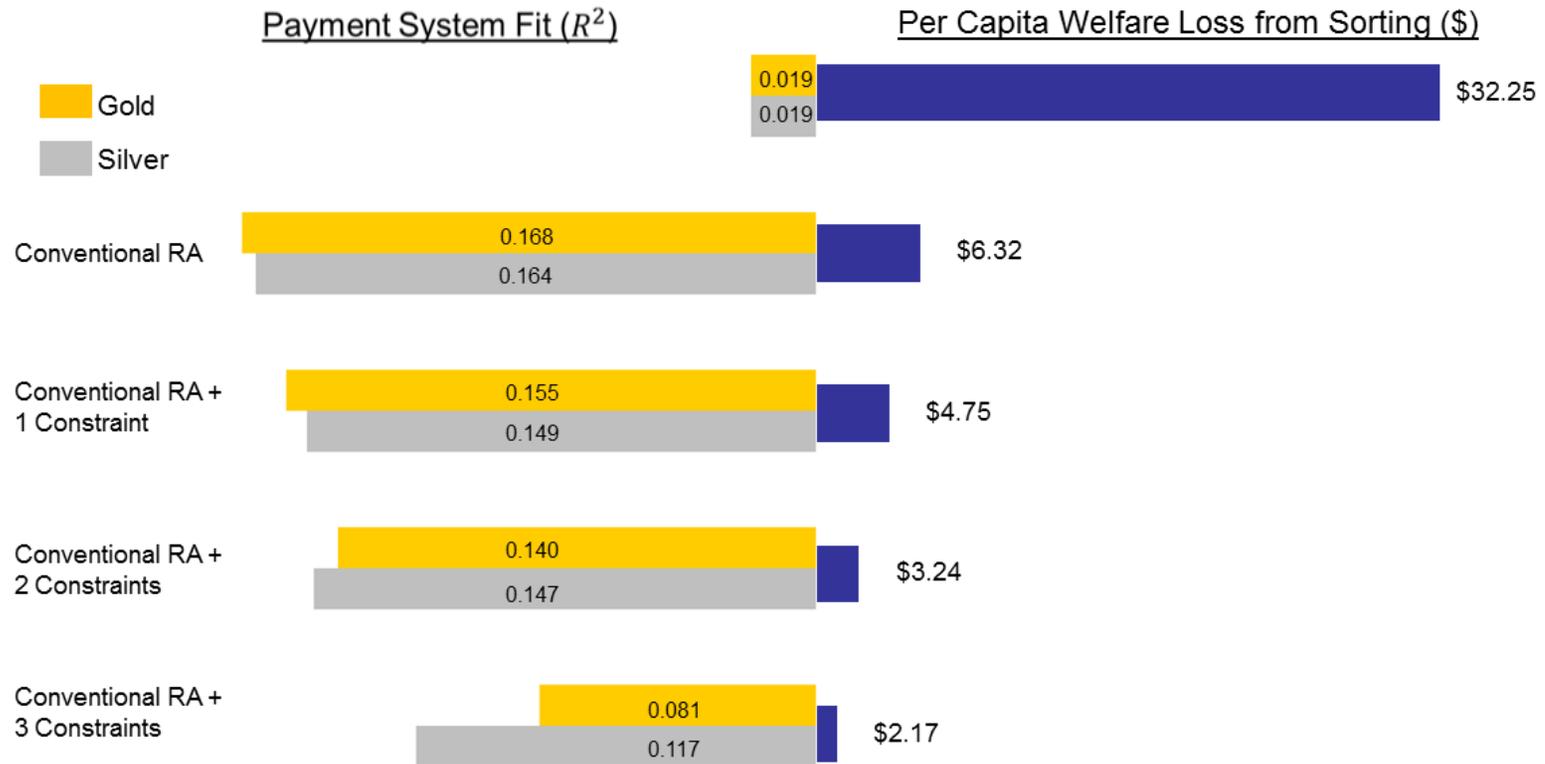
Table A. Changes on the algorithm from ICD-9 codes to CMS-HCCs

Five pregnancy related CCs are added:	

ICD-9 Codes	CCs
650 - 659	200 Normal Delivery
640 - 649	201 Complications mainly related to pregnancy
660 - 669	202 Complications occurring mainly in the course of labor
670 - 677	203 Complications of the puerperium
630 - 639	204 Ectopic and molar pregnancy

Notes: The CCs are sorted as 200, 201, 202, 203 and 204 from least to most severe conditions. Individuals are assigned to the most severe code for hierarchy adjustment if they have multiple conditions.

HCC108 (Chronic Obstructive Pulmonary Disease) is broken into 5 CCs:	
	210 Chronic Obstructive Pulmonary Disease, except asthma
	211 Asthma

HCC 176 (Artificial Openings for Feeding or Elimination) is broken into 3 CCs:	
	220 Diseases of esophagus
	221 Disorders of function of stomach
	222 Other disorders of intestine

Table B. Risk Adjustment Regression Results

	Conventional Risk adjustment	Conventional RA plus 1 constraint	Conventional RA plus 2 constraints	Conventional RA plus 3 constraints	Conventional RA plus premium categories
F18_24	1,234	979	618	739	1,189
	(120)	(120)	(121)	(125)	(192)
F25_34	1,686	1,044	516	481	1,580
	(96)	(94)	(94)	(97)	(186)
F35_44	1,504	1,756	1,741	1,195	1,275
	(96)	(97)	(98)	(101)	(223)
F45_54	1,695	1,906	1,803	630	1,358
	(95)	(96)	(96)	(98)	(228)
F55_64	2,236	2,488	1,714	1,470	1,713
	(120)	(121)	(119)	(123)	(271)
M18_24	387	1,653	2,213	2,146	349
	(111)	(104)	(103)	(107)	(184)
M25_34	582	1,064	802	1,428	463
	(90)	(90)	(90)	(93)	(183)
M35_44	853	962	149	1,112	625
	(93)	(94)	(91)	(93)	(222)
M45_54	1,490	1,632	1,496	47	1,146
	(99)	(99)	(100)	(101)	(230)
M55_64	2,106	2,303	1,626	971	1,586
	(122)	(123)	(122)	(126)	(272)
HCC1	3,235	1,525	1,553	987	3,228
	(445)	(445)	(449)	(464)	(445)
HCC2	2,161	-396	-1,650	-2,058	2,165
	(495)	(492)	(495)	(512)	(495)
HCC5	1,859	1,056	1,491	-219	1,833
	(311)	(312)	(314)	(324)	(311)
HCC7	13,565	14,010	17,368	32,757	13,559
	(885)	(892)	(894)	(893)	(885)
HCC8	13,666	14,094	18,132	30,940	13,653
	(1,186)	(1,195)	(1,199)	(1,225)	(1,186)
HCC9	17,992	13,660	15,212	16,436	17,972
	(870)	(865)	(871)	(901)	(869)
HCC10	5,526	5,171	6,846	7,592	5,510
	(242)	(243)	(240)	(248)	(242)
HCC19	3,423	3,423	4,226	5,701	3,422
	(146)	(147)	(146)	(149)	(146)
HCC26	1,724	1,728	-17	3,768	1,738
	(1,226)	(1,235)	(1,244)	(1,285)	(1,225)

Table C. Risk Adjustment Regression Results_Continued

HCC27	6,104	6,665	11,523	13,455	6,092
	(856)	(862)	(857)	(886)	(856)
HCC31	4,399	4,280	4,477	2,706	4,415
	(610)	(615)	(620)	(641)	(610)
HCC32	10,740	6,514	5,654	9,902	10,746
	(874)	(870)	(877)	(904)	(874)
HCC33	5,085	4,394	7,602	1,892	5,053
	(752)	(757)	(758)	(779)	(752)
HCC37	3,188	3,064	4,221	3,237	3,181
	(353)	(356)	(357)	(369)	(353)
HCC38	2,521	2,426	3,182	3,510	2,498
	(309)	(312)	(314)	(324)	(309)
HCC44	4,382	1,836	1,445	8,343	4,384
	(772)	(773)	(780)	(799)	(772)
HCC45	13,615	10,627	18,130	18,234	13,596
	(1,157)	(1,162)	(1,150)	(1,189)	(1,157)
HCC52	4,125	1,814	1,552	-285	4,101
	(845)	(848)	(856)	(884)	(845)
HCC54	9,373	7,504	9,759	10,135	9,408
	(1,039)	(1,045)	(1,052)	(1,088)	(1,039)
HCC55	4,691	1,619	2,839	-2,409	4,666
	(423)	(414)	(416)	(422)	(423)
HCC69	2,610	867	-591	-34	2,629
	(1,160)	(1,167)	(1,177)	(1,217)	(1,160)
HCC71	5,693	6,608	8,959	7,238	5,628
	(1,242)	(1,251)	(1,260)	(1,303)	(1,242)
HCC72	17,470	11,637	17,896	23,631	17,483
	(1,005)	(995)	(986)	(1,016)	(1,005)
HCC73	2,308	2,912	3,039	6,759	2,268
	(600)	(604)	(609)	(627)	(600)
HCC74	3,811	2,021	2,206	2,137	3,783
	(762)	(765)	(772)	(798)	(762)
HCC75	4,761	4,211	3,744	12,631	4,665
	(1,283)	(1,292)	(1,304)	(1,341)	(1,283)
HCC77	3,309	3,359	4,212	5,694	3,302
	(618)	(623)	(628)	(649)	(618)
HCC79	4,219	4,457	6,112	3,250	4,193
	(840)	(846)	(852)	(880)	(840)
HCC80	5,689	5,132	5,239	9,801	5,689
	(362)	(364)	(367)	(373)	(362)
HCC82	12,477	12,748	13,539	21,898	12,459
	(463)	(467)	(470)	(469)	(463)

Table C. Risk Adjustment Regression Results_Continued

HCC83	3,175	3,575	3,935	10,243	3,169
	(640)	(645)	(650)	(665)	(640)
HCC92	3,943	3,638	4,446	6,567	3,921
	(418)	(421)	(424)	(437)	(418)
HCC96	10,126	9,283	10,383	18,664	10,141
	(601)	(605)	(609)	(617)	(601)
HCC104	5,493	5,401	7,983	6,390	5,486
	(315)	(317)	(310)	(320)	(315)
HCC105	12,741	10,681	16,124	16,048	12,727
	(639)	(640)	(625)	(646)	(639)
HCC119	3,332	2,721	3,132	2,878	3,323
	(404)	(407)	(410)	(424)	(404)
HCC130	11,775	8,768	6,748	28,180	11,752
	(1,059)	(1,062)	(1,069)	(1,055)	(1,058)
HCC131	19,239	17,584	20,490	25,724	19,213
	(870)	(875)	(878)	(905)	(870)
HCC148	5,553	5,115	6,969	3,552	5,542
	(677)	(682)	(686)	(707)	(677)
HCC155	3,652	610	-90	-377	3,638
	(581)	(576)	(581)	(601)	(581)
HCC157	2,426	2,648	3,360	4,350	2,403
	(291)	(293)	(294)	(304)	(291)
HCC158	10,164	8,106	10,103	9,323	10,171
	(1,133)	(1,140)	(1,148)	(1,187)	(1,133)
HCC164	9,777	7,578	10,176	17,833	9,767
	(647)	(647)	(648)	(660)	(646)
HCC174	7,067	7,526	9,599	26,982	7,045
	(1,482)	(1,493)	(1,504)	(1,532)	(1,482)
HCC177	3,154	3,404	3,877	12,066	3,145
	(975)	(982)	(990)	(1,016)	(974)
HCC200	6,328	-368	-2,848	-4,376	6,354
	(754)	(728)	(730)	(755)	(754)
HCC201	5,686	3,693	4,600	991	5,671
	(689)	(691)	(696)	(718)	(689)
HCC202	11,055	-1,929	-6,509	-9,379	11,038
	(901)	(804)	(799)	(825)	(901)
HCC203	4,815	6,179	12,491	2,168	4,808
	(1,588)	(1,600)	(1,602)	(1,649)	(1,588)
HCC204	1,658	-839	-2,059	-1,987	1,680
	(674)	(674)	(679)	(702)	(674)
HCC210	4,423	4,772	5,789	11,528	4,407
	(347)	(350)	(351)	(352)	(347)

Table C. Risk Adjustment Regression Results_Continued

HCC211	1,742	1,121	2,025	221	1,705
	(204)	(205)	(205)	(210)	(204)
HCC220	3,442	3,251	4,612	4,261	3,429
	(177)	(178)	(175)	(181)	(177)
HCC221	2,729	1,766	1,854	2,571	2,733
	(300)	(301)	(303)	(314)	(300)
HCC222	5,297	4,662	6,597	8,292	5,275
	(665)	(669)	(673)	(695)	(664)
small_hcc	5,968	6,565	19,033	-1,637	5,939
	(951)	(958)	(891)	(864)	(951)
Restriction (Young_Northeast)		-3E+08	-5E+08	-5E+08	
		(1E+07)	(1E+07)	(1E+07)	
Restriction (Mid_Northeast)		6E+08	-4E+08		
		(2E+07)	(2E+07)		
Restriction (Old_Northeast)			9.4E+08		
			(1E+07)		
Young_Midwest					375
					(208)
Young_South					24
					(186)
Young_West					-119
					(192)
Mid_Northeast					673
					(234)
Mid_Midwest					439
					(223)
Mid_South					12
					(210)
Mid_West					173
					(214)
Old_Northeast					479
					(289)
Old_Midwest					770
					(259)
Old_South					489
					(259)
Old_West					430
					(267)
R-Square	0.236	0.224	0.211	0.156	0.236

Source: MEPS, 2004-2010, N=64,667.

All dollar estimates reported in $2010, and standard errors are shown in parentheses.