# Online Appendix

## Dominated Options in Health-Insurance Plans

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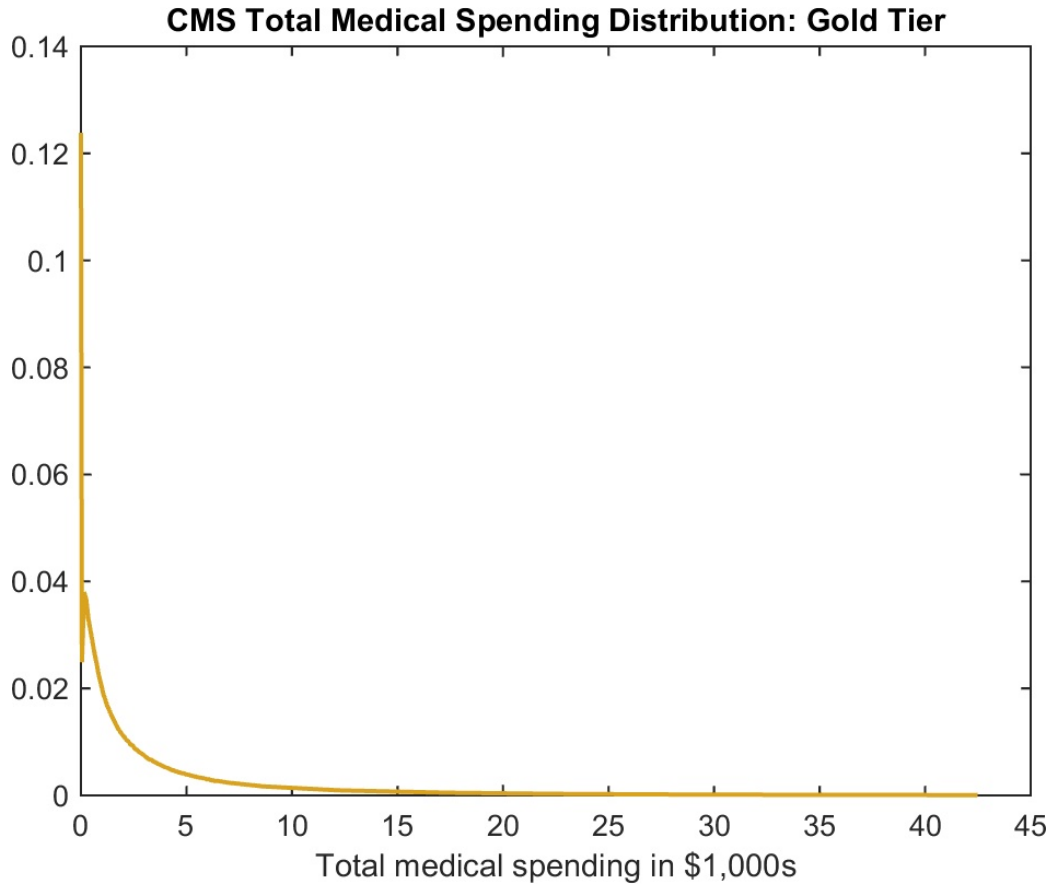
## Appendix Figure 1. CMS Total Medical Spending Distributions




*Notes:* Data from continuance tables provided by CMS for estimating the actuarial value of plans in the Affordable Care Act exchanges. The distribution corresponds to Gold metal tier. The plot shows the fraction of individuals with spending within a $100-bin of spending. The intercept shows the fraction of individuals with zero spending.

## Appendix A. Analyses with Family Coverage

We can also do a limited version of this same analysis for the family-coverage data. The KFF data do not have information about the maximum-out-of-pocket limit for family coverage tiers. However, they do have information about the family deductible level for each plan. That information still may be somewhat incomplete for family coverage, because family coverage often included individual-specific sub-deductibles along with the overall family deductible. However, analyzing the information we do have gives us at least suggestive evidence that the issues we document here for single-coverage tiers likely also apply for family coverage. In particular, we compare the net difference in premiums (including HSA/HRA contributions) between HD and LD plans to the net difference in deductibles between plans for both single and family coverage. We find that for single coverage, 140 of the 331 firms offer a greater net premium reduction for choosing the HD plan than the deductible difference. For the family-coverage tier we find that 186 of the 331 firms have a larger net premium difference than deductible difference, which suggests this issue is likely to be at least as prevalent for family coverage. We further find that of the cases where the single coverage tier shows this pattern of higher net premium differences than deductible differences, that also holds for the family coverage tier at those firms in 85% of cases.

## Appendix B. Creating Simplified Plan Representations

In our main analysis, we create a simplified plan representation for each plan (deductible, coinsurance and maximum out-of-pocket limit). In our sample, there are 146 plans that are originally simple plans. For the rest, we follow the approach in Ericson et al. (forthcoming) to create a simplified plan representation using the CMS AV Calculator.

When calculating actuarial value and the equivalent coinsurance rate, we ignore the following features reported in the Kaiser Family Foundation Survey data that are not supported by AV Calculator:

1. maximum and/or minimum limit for coinsurance payment
2. separate deductible for hospital and/or outpatient surgery
3. If the cost-sharing rule is paying both coinsurance and copayment, we treat it as paying whichever is higher. The former is not supported by CMS AV calculator.

For drug cost sharing features, the KFF survey uses different category labels than the CMS AV calculator. We make the following assumptions in mapping the KFF data to the CMS AV calculator:

1. We map tier 1-4 cost-sharing rule for drugs in the KFF data to generics, preferred brand drugs, non-preferred brand drugs, and specialty drugs in the CMS AV calculator respectively.
2. If a plan has a 2-tier drug cost-sharing rule, we use the cost sharing information for the first tier for tier 1 drug, and second tier sharing rule for 2-4 tiers. We do the same thing for 1-tier and 3-tier plans.
3. The only exception to 2) is when the plan does not cover specialty drugs. If that is the case, we indicate tier-4 cost sharing rule as not covered by the plan.

As mentioned in the main text, there are a few complications to the basic approach. Specifically, about 40% of plan designs have office visits copays before the deductible and/or separate deductibles for drug coverage. To get the simplified plan representation for these plans, we follow the procedures below.

First, we take the AV Calculator distribution (Appendix Figure A). For each total expenditure level **x**, we split it into three categories: office visits, prescription drugs, and all other services. Following the approach in Ericson et al. (forthcoming), we calculate out-of-pocket spending given total spending **x** in the following steps:

*Step 1:* determine which services are subject to the general deductible. Index them with $g$. Split **x** into spending on each service using information from the Gold continuance table from CMS AV Calculator. Denote the amount of spending on services subject to the general deductible as $\boldsymbol{x_g}$. For example, if drugs are not subject to general deductible, and represents 20% of total spending at **x**, then $g$ represents all services other than drug, and $\boldsymbol{x_g} = (1 - 0.2)\boldsymbol{x} = 0.8\boldsymbol{x}$.

*Step 2:* input all plan information into AV calculator and get the actuarial value for the plan. We show the details of how we map KFF data into the AV Calculator below. In this and the next step, we set the underlying metal tier as Gold. (We also tried other metal tiers, the numbers are very close.)

*Step 3:* keep cost-sharing feature of services not subject to the deductible as given, remove all other copay or coinsurance (i.e., on services subject to the general deductible), and input the deductible and MOOP of the plan. Find a single coinsurance rate paid by enrollee that gives the same AV as calculated in step 2. We label it as $co_g$. The idea is to convert complicated cost sharing feature into an equivalent single coinsurance rate. If all services subject to general deductible have the same coinsurance rate, then $co_g$ will be that number. Intuitively, $co_g$ is the average amount an enrollee needs to pay for each dollar of medical services after the deductible is met for services subject to the general deductible.

*Step 4*: calculate the out-of-pocket for services subject to the general deductible at each level of total spending $\boldsymbol{x}$ as:

$$oop_g = \mathbb{I}(\boldsymbol{x_g} > ddct_g) \cdot co_g \cdot (\boldsymbol{x}_g - ddct_g) + \min(\boldsymbol{x}_g, ddct_g).$$

*Step 5*: If office visits are not subject to the general deductible, calculate the out-of-pocket spending on office visits $oop_{ov}$ . Let $\mathbf{x_{ov}}$ denote the portion of total spending on office visits. For example, if at total spending level $\mathbf{x}$, 10% is spent on office visits, then $\mathbf{x_{ov}} = 0.1\mathbf{x}$. Let $\mathrm{co}_{ov}$ denote the equivalent coinsurance rate for office visits. If the plan has coinsurance rate for office visits, then $\mathrm{co}_{ov}$ is that coinsurance rate. If the plan has copayment for office visits, then

$$\mathrm{co}_{ov} = \frac{copay * \#\ of\ visits\ per\ year}{x_{ov}}.^{1}$$

Then the out-of-pocket spending on office visits $\mathrm{oop}_{ov}$ is

$$oop_{ov} = \boldsymbol{x_{ov}} \cdot co_{ov},$$

*Step 6*: In the KFF EHBS and AV Calculator, drugs are split into four tiers. If drugs have a separate deductible, calculate the drug cost sharing $co_d$ for each tier in the same way as for office visits (Step 5). Then the drug out-of-pocket spending is:

$$oop_d = \left(\sum_{i=1}^{4} \mathbb{I}(\boldsymbol{x_d} > ddct_d) \cdot co_{di} \cdot \boldsymbol{x_{di}}\right) + \min(\boldsymbol{x_d}, ddct_d),$$

[1] In a few rare cases, this rate is higher than 1, implying that the copayment amount is higher than $x_{ov}$. When this happens, we replace $co_{ov}$ by 1. This is consistent with the AV Calculator methodology.

where $\boldsymbol{x_d}$ is the total drug spending at total spending level $\boldsymbol{x}$, $\boldsymbol{x_{di}}$ is the amount spent on each tier beyond the deductible range. We determine $\boldsymbol{x_{di}}$ based on the proportion of spending on each tier. For example, if there is a drug deductible of $100, and at total spending level $\$\boldsymbol{x}$, the spending on drugs tier 1-4 is $30, $40, $30, and $20 respectively, and exceed the deductible by $20. Then we calculate $x_{d1} = 20 * \frac{30}{40+30+30+20} = \$5$. The calculations for other tiers are similar.

*Step 7*: Then the total spending over the year is:

$$p + oop = p + \max\{\min(oop_g + oop_{ov} + oop_d, m) - HRA, 0\}.$$

$p$ is the net premium (employee premium minus any firm contribution to HSA), $m$ is the MOOP of the plan, HRA is the amount that the firm contributes into health reimbursement arraignment. According to the definition of HRA contribution, we treat this value as a reduction of out-of-pocket cost: if enrollees have no out-of-pocket cost, they cannot use the money. They also cannot withdraw the money or take the money if they leave the firm.

To make sure the main results are not driven by the judgement calls we made here, we show in Appendix Table B1 that the main results are robust if we consider only cases where we do not need to make any judgement calls. Similarly, the KFF survey data contains a small number of imputed values, but we find that the results are not affected if we limit to the subsample with no imputed values.[2] Finally, we find that the CMS AV calculator can generate errors at times in situations where the plan cost-sharing rules involve per-day copays for inpatient stays. Again, we find that the results are unchanged if we limit to firms without these types of copays.

[2] The KFF survey imputes values for a limited number of cases with missing values, which occurs for about 5% of observations. In our matched sample, none of the main variables like premium, deductible, HSA contribution, coinsurance rate and copayment amount for inpatient stay are imputed. Some other variables are imputed in rare cases by KFF by replacing "the missing information with observed values from a firm similar in size and industry to the firm for which data are missing" (KFF, 2015).

## Appendix Table B1. Robustness Checks

| | | Number of Firms | Share of HD Strictly Dominant | Average Expected Net Savings with HD plan |
|---|---|---|---|---|
| B1a | Basic Analysis | 331 | 37% | $569 ($734) |
| B1b | Sample without Judgement Calls | 166 | 35% | $580 ($730) |
| B1c | Sample without Imputation | 280 | 38% | $572 ($687) |
| B1d | Sample without Inpatient Copay | 275 | 36% | $594 ($751) |

*Notes*: Standard deviation is in parentheses. The average expected savings is calculated using the CMS Gold-tier continuance table distribution of total medical spending. We made reasonable judgment calls when calculating the actuarial value, as described in Appendix D. B1b takes the subsample of firms without any such judgement calls. KFF data contain ~5% imputation. B1c removes firms with any form of imputation. B1d includes firms that have no copayment as cost-sharing for hospital stays for both the LD and HD plans. (They may have coinsurance rate for hospital stay though.) Data is from Kaiser Family Foundation Employer Health Benefits Survey (2015) and CMS AV Calculator Gold continuance table.

### Appendix C. Sample Construction

Appendix Table C1 gives a breakdown of our sample construction. There are a total of 1,771 firms that responded to the 2015 version of the Kaiser Family Foundation Employer Health Benefits Survey and reported offering at least one health insurance plan to their employees. Among these firms, we dropped firms with missing or contradictory plan information for any of the plans they reported on, leaving us with 2372 plans offered by 1529 firms. This is our full sample.

In the cleaning step going from firms in category 1 (firms reported offering at least one health plan) and to the subsample of firms in category 2 (firms with complete and consistent plan information), we dropped the firms with any health plan with the following features:

1. Missing plan information
    a. No cost-sharing information
    b. No maximum out-of-pocket amount
2. Contradictory plan information
    a. Plan information not consistent with plan type variable

b. HDHP with neither health savings account (HSA) nor health reimbursement arrangement (HRA) information. (By definition of the survey, plans must have either HSA or HRA to be classified as HDHP.)
c. Deductible amount is larger than maximum out-of-pocket amount
d. Deductible amount is the same as maximum out-of-pocket amount, but there is cost-sharing after the deductible range
e. Deductible amount is smaller than maximum out-of-pocket amount, but there is no cost-sharing after deductible for any service

3. Potential data error
    a. Deductible amount or maximum out-of-pocket amount is not divisible by 5

We also confirmed that the remaining HD plans satisfy the IRS regulation on HDHP. [3]

From the main sample we then restrict our sample to firms reporting details for 1 HD plan and 1 LD plan, which is a sample of 373 firms with 746 plans. To be consistent with later analysis, we further dropped 42 firms with at least one plan that has cost-sharing features that are not compatible with the Centers for Medicare and Medicaid Services (CMS) Actuarial Value Calculator. This leaves us with 331 firms offering 662 plans. This is our analysis sample (matched sample).

The cleaning step going from firms in category 3 (Firms offering both 1 HD and 1 LD) to the sub-sample of firms in category 4 (Firms offering both 1 HD and 1 LD and features consistent with AV calculator), we dropped firms with any health plan with the following features:

1. Maximum out-of-pocket amount larger than $6850 (this is the upper bound imposed by CMS Actuarial Value calculator) [1 Firm; 1 LD plan]
2. There is a copayment for outpatient surgery (CMS AV calculator only supports coinsurance rate for this type of services). [41 Firms; 40 LD plans; 6 HD plans]

[3] For an HDHP, there is regulation on a) caps of maximum out-of-pocket value for HDHP (for individual coverage, $6450 in 2014 and $6600 in 2015) and minimum deductible value (for individual coverage, $1250 in 2014, $1300 in 2015).

## Appendix Table C1. Sample Construction

| | | Number of firms | Number of plans |
|---|---|---|---|
| 1 | Firms offering at least one health plan | 1760 | 2714* |
| 2 | Firms offering 1 HD plan and 1 LD plan | 417 | 834* |
| 3 | Firms with complete premium and MOOP information (worst-case scenario sample) | 405 | 810 |
| 4 | Firms with plan information consistent with CMS AV Calculator (matched sample) | 331 | 662 |

*Notes:* Each row represents a subsample of the above row. *In Row 1 and 2 we count the number of plans with any plan information. In some cases, the information is incomplete, which may imply that these are not actually available plans.

## Appendix Table C2. Summary Statistic

| | Full Sample of Firms Offering at Least One … | | Matched Sample Offering Both HD & LD | |
|---|---|---|---|---|
| | **LD Plan** | **HD Plan** | **LD Plan** | **HD Plan** |
| **Panel A: Plan Level Variables** | | | | |
| Deductible | $712 ($900) | $2156 ($1003) | $846 ($813) | $2166 ($986) |
| Maximum Out-of-Pocket | $3282 ($1671) | $4127 ($1370) | $3464 ($1488) | $4011 ($1354) |
| Total Premium | $6699 ($1904) | $5667 ($1638) | $6482 ($1748) | $5453 ($1463) |
| Workers' Premium Share | 0.21 | 0.17 | 0.23 | 0.16 |
| Workers' Premium Paid ($) | $1349 ($1008) | $911 ($728) | $1450 ($825) | $841 ($616) |
| Self-insured | 0.55 | 0.64 | 0.71 | 0.74 |
| Share of Firm offering HSA | | 0.78 | | 0.86 |
| HSA Contribution if Offering | | $506 ($501) | | $473 ($404) |
| Share of Firm Offering HRA | | 0.22 | | 0.14 |
| HRA Contribution if Offering | | $1068 ($909) | | $758 ($583) |
| Actuarial Value* | 85% (7%) | 75% (6%) | 83% (6%) | 74% (5%) |
| Number of plans | 1661 | 710 | 331 | 331 |
| **Panel B: Firm Level Variables** | | | | |
| 1000+ Employees | 0.51 | 0.57 | 0.64 | |
| At least 35% Aged 50+ | 0.47 | 0.47 | 0.46 | |
| At least 35% Earn $58k+ | 0.45 | 0.51 | 0.50 | |
| Private For-Profit | 0.56 | 0.65 | 0.63 | |
| Have Union Worker | 0.31 | 0.29 | 0.31 | |
| Number of firms | 1333 | 710 | 331 | 331 |

*Notes:* Means with standard deviations in the parentheses. Data from Kaiser Family Foundation Employer Benefits Survey (2015). *Authors' calculation using CMS 2015 Actuarial Value Calculator Gold tier. All plans in the matched sample (Columns 3 & 4) have calculated AV values, while Columns 1 & 2 report AV for a subsample (1,259 firms) with plan features compatible with the AV calculator.

## Appendix D. Method of Calculating Plan Values with Tax and Investment Considerations

In this appendix, we detail our method for calculating the value of HD and LD options when there are tax and investment considerations. Throughout the Appendix, we use the following notation:

**Table D1. Notation and Assumptions on Key Parameters**

| | description | value |
|---|---|---|
| $x$ | present value of net income after medical expenditure and tax | See below |
| $s$ | out-of-pocket spending, a function of plan type ($s_L$ denote the out-of-pocket spending under LD, $s_H$ demote the out-of-pocket spending under HD before applying HSA/HRA contribution) | data |
| $p$ | employee premium | data |
| $y$ | total pre-tax income | NA (drops) |
| $h_s$ | employer contribution to HSA | data |
| $h_r$ | employer contribution to HRA | data |
| $\tau$ | tax rate on income. | 0.25 |
| $\tau_r$ | tax rate on interests earned. | 0.25 |
| $l$ | maximum annual individual HSA contribution (including both employer portion and employee portion) | 3350 |
| $d$ | annual discount rate | 0.01 |
| $t$ | investment periods | 30 |
| $r$ | annual interest rate | 2% or 8% |

Enrollees face uncertainty in the health shock, thus the net income after medical expenditure is state-dependent. A plan's financial value is calculated as expected utility over $x$. We assume CARA utility function so $y$ will be dropped in the calculation and can be interpret as income after consumption other than medical spending. For simplicity, we drop the state index and detail how $x$ is determined under different assumptions.

**Case 1. Tax deduction from HSA/HRA, no investment or extra contribution**

In this case, we assume enrollees pay premium using pre-tax dollar. LD enrollees pay out-of-pocket spending using post-tax dollars. HD enrollees first pay out-of-pocket spending using employer contributions to HRA or HSA, and then pay the rest out-of-pocket spending using post-tax dollars.

The net income after medical expenditure in each plan is:

| | |
|---|---|
| LD | $x_L = (1-\tau)(y-p_L) - s_L$ |
| HD (with HSA) | $x_H = (1-\tau)(y-p_H) + h_s - s_H$ |
| HD (with HRA) | $x_H = (1-\tau)(y-p_H) + (h_r - s_H)(h_r \le s_H)$ |

**Case 2. Tax deduction from HSA/HRA, no investment, self-contribution up to the limit**

In this case, we assume enrollees in HD with HSA make self contributions up to the limit (the limit applies to both their own contribution and employer contribution) and can pay out-of-pocket pre-tax with these contributions. The rest out-of-pocket spending, if there is any, is paid with post-tax dollars. The net income after medical expenditure for enrollees with HD and HSA is:

$$x_H = (1-\tau)(y-p_H) + (h-s_H)(h \le s_H).$$

For LD enrollees and HD enrollees with HRA, Case 2 is the same as Case 1.

**Case 3. Invest remaining income, tax deduction from HSA, no extra contribution**

For LD enrollees, we assume they pay premium with pre-tax dollar and pay out-of-pocekt spending with post-tax dollar. They then invest all the remaining income. Enrollees need to pay tax on the total interests earned (deducted at the end of the entire investment period at one time). The present value of their net income is:

$$x_L = \frac{(B(1+r)^t - B)(1-\tau_r)}{(1+d)^t} + B,$$

$$\text{where } B = \big((y-p_L)(1-\tau) - s_L\big).$$

For enrollees in HD with HSA, they pay premium with pre-tax dollars and pay out-of-pocket spending with post-tax dollars. They invest employer contributions to HSA and pay no tax on the interest earned. Finally, they invest the remaining income and pay interest rate tax. The present value of their net income is:

$$x_H = \frac{(C(1+r)^t - C)(1-\tau_r)}{(1+d)^t} + C + \frac{h(1+r)^t}{(1+d)^t},$$

$$\text{where } C = \big((y-p_H)(1-\tau) - s_H\big).$$

For enrollees in HD with HRA, they first pay out-of-pocket spending using employer contribution to HRA, and then pay the rest out-of-pocket spending using post-tax dollar. They then invest the remaining income and pay interest rate tax. The present value of their net income is:

$$x_H = \frac{(A(1+r)^t - A)(1-\tau_r)}{(1+d)^t} + A,$$

$$\text{where } A = \big((y-p_H)(1-\tau) - (s_H - h)(s_H \ge h) + (h-s_H)(s_H < h)\big).$$

**Case 4. Invest remaining income, tax deduction from HSA, self-contribution up to the limit**

For LD enrollees and HD enrollees with HRA, Case 4 is the same as Case 3.

HD (with HSA): different from case 3, in this case enrollees contribute to the maximum amount allowed into the HSA account. Investment in their HSA is exempt from interest rate tax:

$$x_H = \frac{(D(1+r)^t - D)(1-\tau_r)}{(1+d)^t} + D + \frac{l(1+r)^t}{(1+d)^t},$$

where $D = \big((y - p_H - (l-h))(1-\tau) - s_H\big)$.