MEMORANDUM

DATE: July 15, 2016

FROM: Richard S. Foster

TO: CHOICES Executive Committee

SUBJECT: Method to Address Estimation Bias in the HHS-HCC Risk Adjustment Model

The current HHS-HCC risk adjustment model established by CMS is known to understate risk scores for relatively healthy individuals and to overstate them for those with significant health conditions. As indicated in Exhibit 7 from "The HHS-HCC Risk Adjustment Model for Individual and Small Group Markets under the Affordable Care Act,"[1] the model's predicted expenditures for the 40 percent of adults with the lowest health care costs, in a theoretical Catastrophic plan, were 35 percent below the actual costs for this group. Conversely, predicted expenditures for the 10 percent with the highest expenditures in a theoretical Silver plan were 6 percent greater than the actual amount.

Milliman, Inc. and others have also noted this estimation bias in the HHS-HCC risk adjustment model.[2] CMS has correctly stated that the *overall* impact of the bias is small: "Since most of the dollars are in the highest percentiles, it is most important for the model to perform well for these high cost subgroups."[3] However, for plans with relatively healthy enrollees, such as many Catastrophic and Bronze plans, the bias can cause a significant overstatement in the risk adjustment charges that such plans must pay. In recognition of this issue, CMS is changing how the risk adjustment model is calibrated, starting with plan year 2017, by "predicting plan liability adjusted to account for preventive services without cost sharing." They note, "we expect that the incorporation of preventive services will increase the risk scores of bronze and silver plans with healthier enrollees relative to other plans' risk scores."[4] It is not clear whether this change will fully remove the existing estimation bias.

As it happens, there is a fairly easy way to address this bias in the RA model that could be used on a practical basis by State insurance departments for the 2015 and 2016 plan years. This note describes an adjustment process that removes virtually all of the bias in HHS-HCC risk scores. The adjusted risk scores could then be substituted for the original ones in the Risk Transfer Formula to calculate more accurate risk adjustment transfers for a State's market rating areas.

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[1] John Kautter, Gregory C. Pope, Melvin Ingber, Sara Freeman, Lindsey Patterson, Michael Cohen, and Patricia Keenan. "The HHS-HCC Risk Adjustment Model for Individual and Small Group Markets under the Affordable Care Act." *Medicare & Medicaid Research Review*, 4:3 (2014): E22. Available at https://www.cms.gov/mmrr/Downloads/MMRR2014_004_03_a03.pdf.

[2] Siegel, Jason and Petroske, Jason. "When adverse selection isn't: Which members are likely to be profitable (or not) in markets regulated by the ACA." *Milliman Healthcare Reform Briefing Paper*, December 2013. Available at http://us.milliman.com/insight/2013/When-adverse-selection-isnt-Which-members-are-likely-to-be-profitable-or-not-in-markets-regulated-by-the-ACA/.

[3] Kautter, Pope, Ingber, *et al.* E23.

[4] Centers for Medicare & Medicaid Services. "Patient Protection and Affordable Care Act; HHS Notice of Benefit and Payment Parameters for 2017." *Federal Register*, 81:45. March 8, 2016: 12218. Available at https://www.federalregister.gov/articles/2016/03/08/2016-04439/patient-protection-and-affordable-care-act-hhs-notice-of-benefit-and-payment-parameters-for-2017 - h-44.

This process has the following advantages and one key limitation:

- The calculation would eliminate virtually all of the tendency in the existing risk adjustment model to understate risk scores for healthy individuals and groups and to overstate risk scores for those with significant health conditions.
- The adjustment would use the exact same factors to calculate the risk adjustment transfers as originally used by CMS, with the exception that the biased plan liability risk scores would be replaced with adjusted scores for each plan.
- The transfer formula factors should be readily available to the States from CMS.
- The adjusted risk scores can be calculated using a simple formula based on a plan's unadjusted risk score from the HHS-HCC model and its actuarial value. The same adjustment process would apply to both individual plans and small group plans.
- The HHS-HCC risk adjustment model would not be changed in any way or recalibrated based on other data. The adjustment to the model's risk scores would be based solely on the existing pattern of estimation bias, as documented by the developers of the HHS-HCC model.
- The resulting risk adjustment transfers would continue to sum to zero in each rating area.
- There is a straightforward actuarial basis for making these adjustments, which the NAIC and individual State insurance departments would probably find convincing.
- However, this methodology only addresses the estimation bias in the risk adjustment model. It does not adjust for missing or incomplete data on enrollees' health conditions, relative plan efficiency, partial year enrollees, or the impact of using the Statewide average market premium rather than plans' own premiums or medical expenditures.

Development of adjustment formula

The developers of the HHS-HCC risk adjustment model published a comprehensive description of the model in the *Medicare & Medicaid Research Review* in 2014. Their article describes the development of the model, the data sources used in its calibration, how the model is used to calculate risk scores, and how accurately it predicts health plan expenditures for individuals and groups.

Exhibit 7 from this article is reproduced on the following page.[5] It shows the predicted plan expenditures for various subgroups of adults from the 2010 MarketScan Commercial Claims and Encounters Database calibration sample with insurance coverage under a Platinum, Gold, Silver, Bronze, or Catastrophic plan. The subgroups are defined by their level of predicted expenditures (e.g., the lowest 40 percent, the highest 10 percent, and so forth.)

For example, if the 40 percent of adults in the calibration data with the lowest predicted expenditures were enrolled in a representative Platinum plan, the group's average predicted risk score would be 0.467 ("predicted $"), indicating that they would be expected to cost about 46.7 percent of the average for all enrollees of all ages. Conversely, the subset of such

[5] Kautter, Pope, Ingber, *et al.* E22. The corresponding Exhibits 8 and 9 for Child and Infant risk adjustment models, respectively, are shown in the appendix to this note.

individuals with the highest 5 percent of predicted Platinum plan expenditures would have an HHS-HCC risk score of 12.572, or more than twelve times the overall average.

CMS Exhibit 7. Predictive Ratios by Percentiles of Predicted Expenditures—Adult Models

	Percentiles (sorted by predicted $)					
	0–40%	**40–80%**	**80–100%**	**top 10%**	**top 5%**	**top 1%**
Platinum						
Predicted $	0.467	0.927	5.218	8.280	12.572	31.630
Actual $	0.517	0.988	5.012	7.886	11.860	30.531
Predictive Ratio	0.90	0.94	1.04	1.05	1.06	1.04
% of Overall Actual $	11.8	24.2	64.0	50.8	38.1	19.1
Gold						
Predicted $	0.385	0.791	4.847	7.794	11.998	30.813
Actual $	0.437	0.857	4.628	7.368	11.241	29.658
Predictive Ratio	0.88	0.92	1.05	1.06	1.07	1.04
% of Overall Actual $	11.1	23.3	65.6	52.7	40.1	20.5
Silver						
Predicted $	0.274	0.625	4.571	7.473	11.634	30.337
Actual $	0.330	0.693	4.339	7.035	10.859	29.120
Predictive Ratio	0.83	0.90	1.05	1.06	1.07	1.04
% of Overall Actual $	9.5	21.3	69.3	56.7	43.7	22.7
Bronze						
Predicted $	0.160	0.431	4.296	7.206	11.396	30.188
Actual $	0.227	0.505	4.035	6.752	10.618	28.983
Predictive Ratio	0.71	0.85	1.06	1.07	1.07	1.04
% of Overall Actual $	7.5	17.9	74.6	62.9	49.4	26.2
Catastrophic						
Predicted $	0.130	0.376	4.216	7.131	11.328	30.148
Actual $	0.200	0.452	3.944	6.671	10.545	28.947
Predictive Ratio	0.65	0.83	1.07	1.07	1.07	1.04
% of Overall Actual $	6.9	16.8	76.3	65.1	51.4	27.4

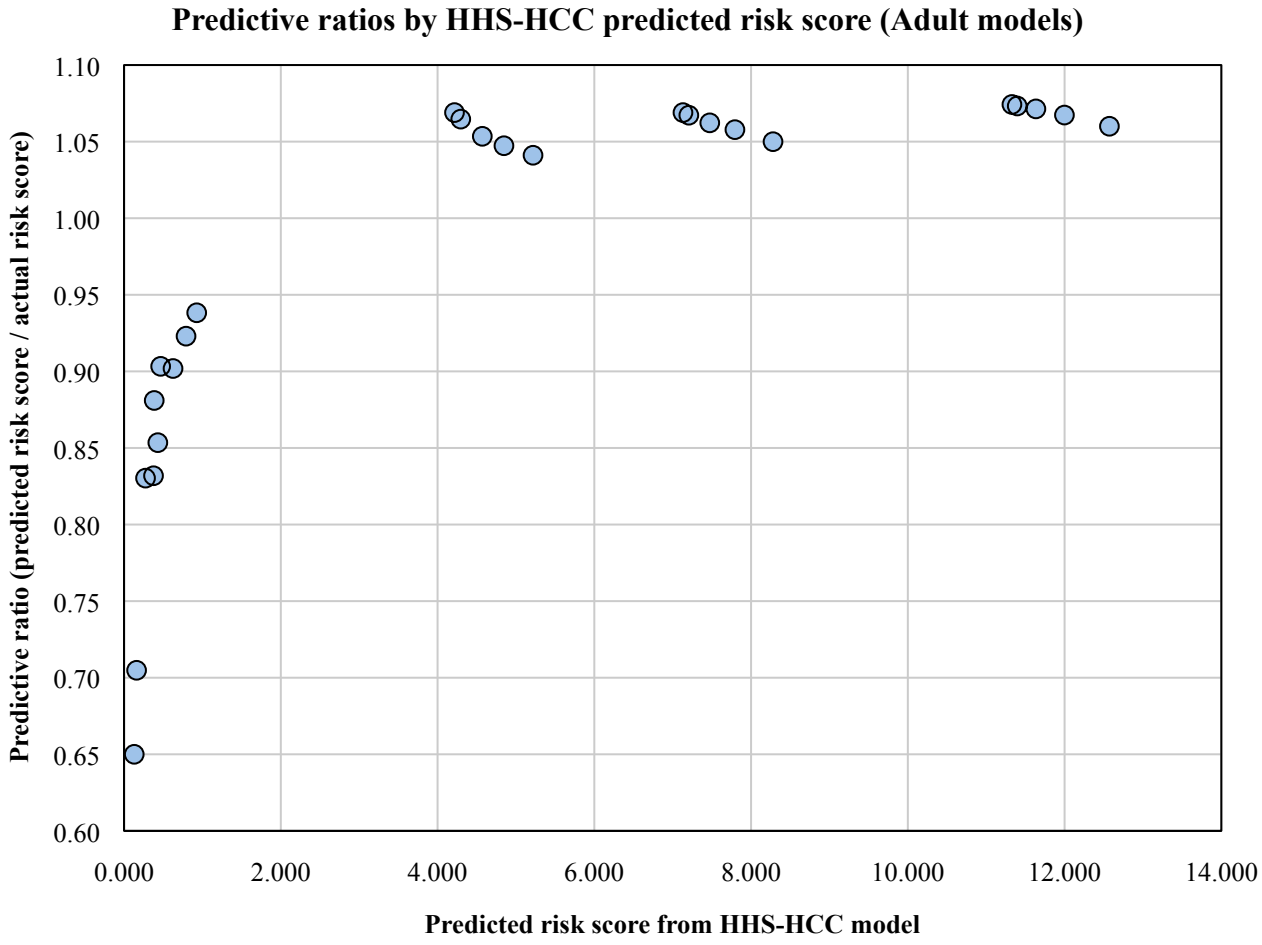
NOTES:
1. Predicted $ are mean relative predicted annualized plan liability expenditures for percentile group.
2. Actual $ are mean relative actual annualized plan liability expenditures for percentile group.
3. Predictive ratio is predicted $ divided by actual $.
4. % of overall actual $ is weighted sum of actual $ for percentile group divided by weighted sum of actual $ across entire adult sample, for each metal tier.
5. For a given model, percentiles are sorted by predicted $ for that model.
6. Adults are age 21+.

SOURCE: Authors' analysis of 2010 MarketScan® Commercial Claims and Encounters Database.

The corresponding *actual* expenditure data from the MarketScan dataset show that the low-cost group's risk score is actually 0.517, or about 10 percent higher than the predicted risk score of 0.467. On the other hand, the group with the highest 5 percent of predicted expenditures has an actual risk score of 11.860, which is about 6 percent less than the predicted score of 12.572.

A similar pattern occurs for the other plan types. The "predictive ratios" shown in Exhibit 7 are a measure of how closely the risk score ("predicted $") from the HHS-HCC risk adjustment model matches the actual underlying risk score ("actual $") for groups of individuals in various expenditure categories and plan types. The predictive ratio is defined as the predicted risk score divided by the actual risk score. For the low-cost and high-cost Platinum group examples cited above, the corresponding predictive ratios are 0.90 and 1.06.

The following chart compares the predictive ratios from Exhibit 7 to the corresponding predicted risk scores from the HHS-HCC model, for the various adult expenditure groups and the five plan categories.



As indicated, the predictive ratios for groups with relatively low risk scores are all below 1.0, while those for groups with higher risk scores are all above 1.0. The deviation from 1.0 averages 12.5 percent.[6] Ideally, the predictive ratios would be close to 1.0 for all expenditure groups and plan types, and any deviations would be randomly above or below this value.

[6] Measured by the root mean squared deviation.

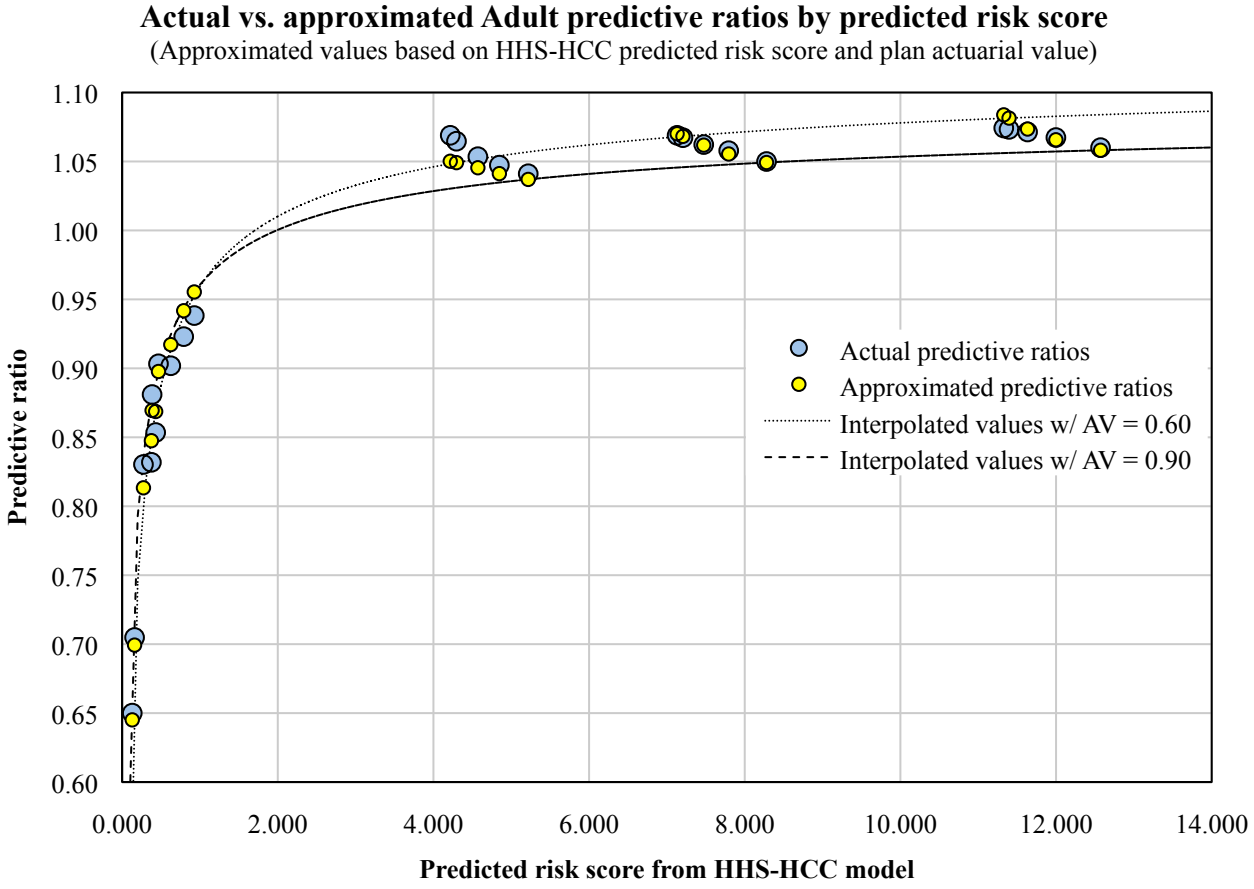
The predictive ratios display a pronounced pattern relative to the corresponding predicted risk scores. If this pattern can be quantified as a function of the predicted risk score (and perhaps additional variables), then it would be possible to approximate the actual plan liability risk score (*PLRS*) as follows:

$$PLRS^{actual} = \frac{PLRS^{actual}}{PLRS^{predicted}} \cdot PLRS^{predicted} = \frac{PLRS^{predicted}}{PLRS^{predicted} / PLRS^{actual}} \approx \frac{PLRS^{predicted}}{predictive\ ratio\ approximation}$$

Fortunately, the pattern of estimation bias shown by the predictive ratio can be approximated closely as a function of the predicted risk score and the actuarial value (*AV*). The following approximation was developed by regressing the actual predictive ratios on the inverse square root of the predicted plan liability risk scores, the plan actuarial value, and an interaction term, using the data for adults from Exhibit 7.[7]

$$Approximated\ adult\ predictive\ ratio = 1.2055 - 0.2486\left(PLRS^{predicted}\right)^{-0.5} - 0.1212(AV) + 0.1253(AV)\left(PLRS^{predicted}\right)^{-0.5}$$

The approximated predictive ratios are compared to the actual values in the following chart:

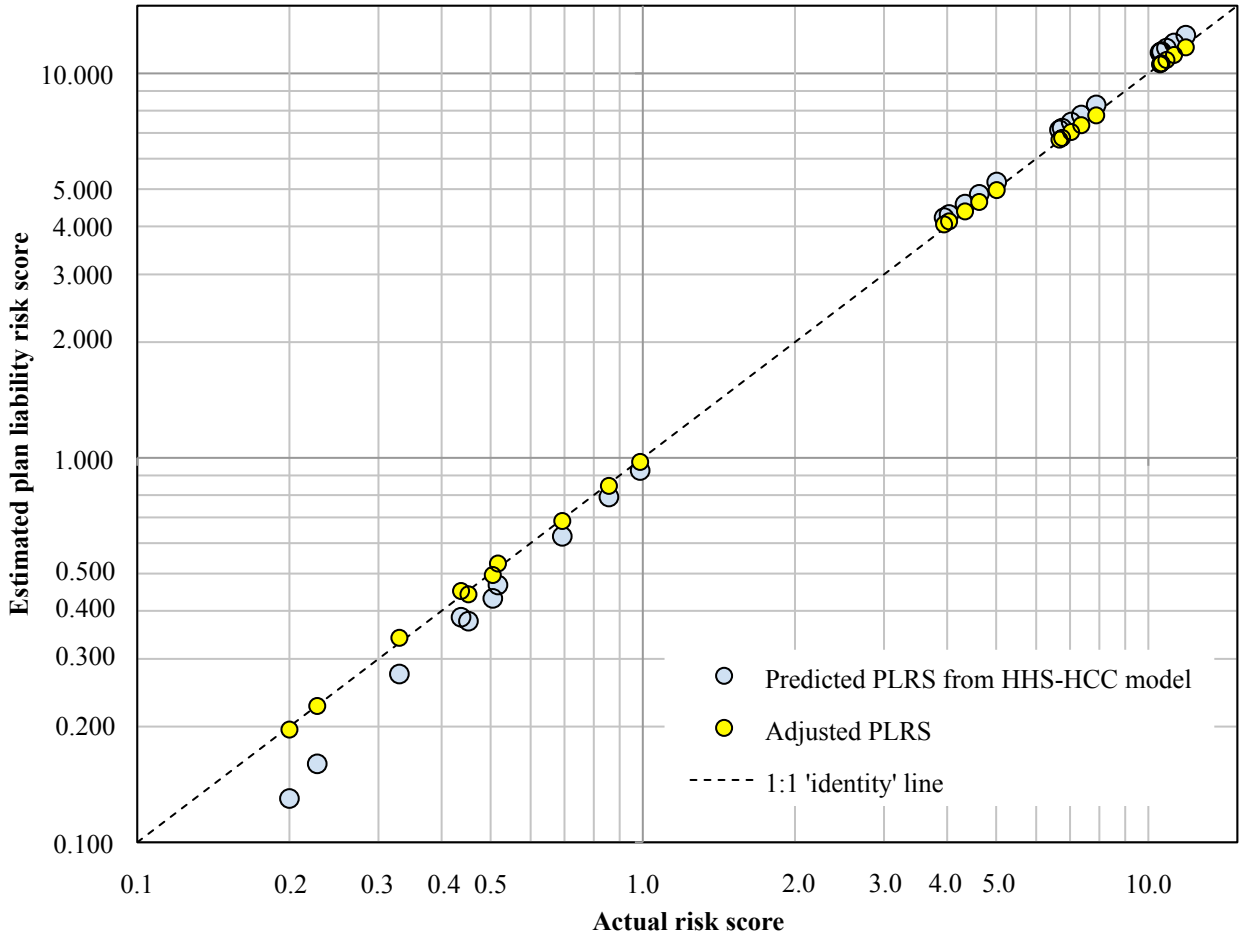


[7] There is a close linear relationship between the predictive ratios and the transformed variable $(PLRS)^{-0.5}$. The regression has an R^2 value above 99 percent, with all coefficients statistically significant and a standard error of the estimate of 0.011.

As indicated, the approximations are all quite close to the actual values. Although there are no data available for adult expenditure subgroups with plan liability risk scores between 1.0 and 4.0, it is reasonable to expect that such groups would contain a mix of individuals with below-average costs and others with above-average costs. Accordingly, the interpolated values shown in the chart above should be representative of subgroups with in-between risk scores. In practice, the 0-40% and 40-80% subgroups used by CMS to evaluate the risk adjustment model's predictive ability would have relatively few members with chronic health conditions. The higher expenditure subgroups (80-100%, top 10%, and top 5%) would have proportionately more members with such conditions.

As noted above, the actual plan liability risk scores can be closely approximated by dividing the original predicted risk scores from the HHS-HCC model by their associated approximate predictive ratios. In this chart, the original and adjusted risk scores are plotted against the actual risk scores for the adult subgroups.[8]

Comparison of predicted vs. adjusted HHS-HCC plan liability risk scores
(Adults; log scale used for clarity)



If the predicted or adjusted risk score for a plan exactly matches the actual value, then its point would fall exactly on the 1:1 "identity line" in the chart. The predicted risk scores from the

[8] A log scale is used to clarify the comparison at both low and high risk-score levels and to indicate the relative differences rather than the absolute differences.

HHS-HCC risk adjustment model fall significantly below this line for groups with low risk scores and slightly above the line for those with high risk scores—illustrating the estimation bias discussed previously. In contrast, the adjusted risk scores differ only negligibly from the actual values.

The following table compares the percentage errors in the predicted risk scores from the HHS-HCC risk adjustment model and those for the adjusted risk scores:

Overstatement (+) or understatement (–) of adult plan liability risk score, in percent

	Expenditure category				
Plan type	0–40%	40–80%	80–100%	top 10%	top 5%
	For predicted risk scores from HHS-HCC model (RMS error = 12.5%)				
Platinum	-9.7%	-6.2%	4.1%	5.0%	6.0%
Gold	-11.9%	-7.7%	4.7%	5.8%	6.7%
Silver	-17.0%	-9.8%	5.3%	6.2%	7.1%
Bronze	-29.5%	-14.7%	6.5%	6.7%	7.3%
Catastrophic	-35.0%	-16.8%	6.9%	6.9%	7.4%
	For adjusted risk scores (RMS error = 1.1%)				
Platinum	0.6%	-1.8%	0.4%	0.1%	0.2%
Gold	1.3%	-2.0%	0.6%	0.2%	0.2%
Silver	2.1%	-1.7%	0.8%	0.0%	-0.2%
Bronze	0.8%	-1.8%	1.5%	-0.1%	-0.8%
Catastrophic	0.8%	-1.8%	1.8%	-0.1%	-0.9%

After adjustment, the risk scores by expenditure level and plan type for adults are all very close to their actual values, and there is minimal estimation bias by expenditure level.

Children and infants

The preceding section of this note describes the methodology for approximating plans' predictive ratios and using the results to adjust the HHS-HCC risk scores to remove estimation bias. The description is based on the data from the CMS Exhibit 7 for adults. In practice, a plan's predicted risk score will reflect the individual risk scores for enrollees of all ages, not just adults.

CMS has established separate risk adjustment models for adults (defined as ages 21 and above), children (ages 2 through 20), and infants (ages 0 and 1). Accordingly, adjusting the plan liability risk scores from the HHS-HCC model should be done using a formula that addresses the estimation bias for all ages, not just adults. In particular, the estimation bias for the child risk adjustment model is very pronounced—much more so than for adults. Using the same expenditure categories and plan types, the predictive ratios for children ranged from 0.08 to 1.30 (see CMS Exhibit 8 in the appendix). The risk adjustment model for infants is based on a different approach and shows very little estimation bias, with predictive ratios ranging from 0.80 to 1.01 (CMS Exhibit 9).

Ideally, the problem of estimation bias would be addressed by recalculating each plan's risk score, individual by individual, using separate adjustments for adults, children, and infants. This approach is not practical for State insurance departments, however, and would be cumbersome even for CMS to perform.

Instead, it is possible to develop a single adjustment formula, much like the one outlined above for adults, which would apply to each plan's combined adult-child-infant risk score. To do so, I regressed the combined predictive ratios (calculated from Exhibits 7, 8, and 9) against the inverse square root of the combined predicted risk scores, the plan actuarial values, and an interaction term. This is the identical methodology described above, but applied to the combined adult-child-infant population subgroups.[9]

$$\textit{Approximated combined predictive ratio} = 1.2139 - 0.2398\left(PLRS^{predicted}\right)^{-0.5} - 0.1247(AV) + 0.1151(AV)\left(PLRS^{predicted}\right)^{-0.5}$$

The age-specific actual and predicted risk scores from Exhibits 7, 8, and 9 were combined into total-plan risk scores by using the November 1, 2015 - February 1, 2016 distribution of plan selections by age and metal level, published by HHS for the States using the HealthCare.gov exchange platform.[10] The combined predictive ratios were calculated from these actual and predicted risk scores, and the resulting values are shown in the appendix.

Distribution of 2016 plan selections by age category and type of plan

Age category	Type of plan					Total, all plans
	Catastrophic	Bronze	Silver	Gold	Platinum	
Infant (0-1)	680	22,224	62,395	11,611	1,332	98,242
Child (2-20)	17,249	256,059	790,118	109,882	12,927	1,186,235
Adult (21+)	81,097	1,782,151	5,970,929	449,834	57,442	8,341,453
Total, all ages	99,026	2,060,434	6,823,442	571,326	71,701	9,625,930

Note: Counts are approximated from HHS age categories of < 18, 18-25, 26-34, 35-44, 45-54, 55-64, ≥ 65.

In practice, of course, the distribution among adults, children, and infants can vary significantly from one plan to another. I tested the accuracy of the above approximation formula when applied to alternative enrollment mixes, based on weights for children and infants that were (i) double the national percentages and (ii) half of the national percentages (with the adult percentages correspondingly adjusted). The table on the following page compares the percentage errors in the combined predicted risk scores from the HHS-HCC risk adjustment model versus the adjusted risk scores (based on the formula above) for the three sets of enrollment weights.

As indicated in the table, the adjusted risk scores largely eliminate the estimation bias in each of the enrollment scenarios. Graphical comparisons of the predictive ratios and plan liability risk scores are shown in the appendix for each enrollment distribution.

[9] As with the adult-only adjustment formula, the regression metrics for the combined adult-child-infant regression are excellent, with $R^2 > 99$ percent, all coefficients statistically significant, and a standard error of the estimate of 0.011.

[10] Department of Health & Human Services. "Health Insurance Marketplaces 2016 Open Enrollment Period: Final Enrollment Report." *ASPE Issue Brief*. March 11, 2016. Available at https://aspe.hhs.gov/sites/default/files/pdf/187866/Finalenrollment2016.pdf.

Overstatement (+) or understatement (–) of combined plan liability risk score, in percent

Plan type	Expenditure category				
	0–40%	40–80%	80–100%	top 10%	top 5%
	For combined predicted risk scores from HHS-HCC model; national enrollment weights for adults, children, and infants (RMS error = 13.3%)				
Platinum	-10.2%	-6.4%	4.3%	5.3%	6.4%
Gold	-12.6%	-8.0%	4.9%	6.1%	7.2%
Silver	-17.8%	-10.1%	5.5%	6.5%	7.5%
Bronze	-31.2%	-15.2%	6.7%	7.0%	7.7%
Catastrophic	-37.9%	-17.8%	7.4%	7.5%	8.3%
	For adjusted combined risk scores; national enrollment weights for adults, children, and infants (RMS error = 1.1%)				
Platinum	0.7%	-1.6%	0.4%	0.1%	0.2%
Gold	1.4%	-1.7%	0.6%	0.2%	0.2%
Silver	1.7%	-1.8%	0.5%	-0.2%	-0.4%
Bronze	0.3%	-1.9%	1.3%	-0.3%	-0.9%
Catastrophic	1.2%	-1.5%	2.0%	0.1%	-0.5%
	For adjusted combined risk scores; twice national enrollment weights for children and infants (RMS error = 1.7%)				
Platinum	1.3%	-0.8%	1.0%	0.7%	0.9%
Gold	2.5%	-0.6%	1.3%	0.8%	0.8%
Silver	2.5%	-1.1%	1.0%	0.3%	0.1%
Bronze	2.0%	-0.6%	1.9%	0.3%	-0.3%
Catastrophic	5.7%	0.7%	3.2%	1.4%	0.8%
	For adjusted combined risk scores; one-half national enrollment weights for children and infants (RMS error = 1.2%)				
Platinum	0.4%	-2.0%	0.1%	-0.2%	0.0%
Gold	1.0%	-2.2%	0.3%	-0.1%	-0.1%
Silver	1.3%	-2.2%	0.3%	-0.4%	-0.6%
Bronze	-0.4%	-2.4%	1.0%	-0.5%	-1.2%
Catastrophic	-0.2%	-2.3%	1.5%	-0.4%	-1.1%

Application of adjusted risk scores to determination of risk adjustment transfers

CMS determines the risk adjustment transfer payments (+) and charges (–) based on the following formula, as shown in "Risk Transfer Formula for Individual and Small Group Markets Under the Affordable Care Act."[11] A plan's transfer (T_i) is a function of its plan liability risk score from the HHS-HCC risk adjustment model ($PLRS_i$) and its "induced utilization factor" (IDF_i), "geographic cost factor" (GCF_i), actuarial value (AV_i), "allowable rating factor" (ARF_i), and its market share (s_i), relative to the average of these factors across all plans in the market rating area. A final factor, for converting these relative values into a dollar transfer amount (per member, per month) is the Statewide average premium ($\overline{P}_s$).

[11] Pope, Gregory C., Bachofer, Henry, Pearlman, Andrew, Kautter, John, Hunter, Elizabeth, Miller, Daniel, and Keenan, Patricia. "Risk Transfer Formula for Individual and Small Group Markets Under the Affordable Care Act." *Medicare & Medicaid Research Review*, 4:3 (2014): E4. Available at https://www.cms.gov/mmrr/Downloads/MMRR2014_004_03_a04.pdf.

$$T_i = \left[\frac{PLRS_i \cdot IDF_i \cdot GCF_i}{\sum_i \left(s_i \cdot PLRS_i \cdot IDF_i \cdot GCF_i \right)} - \frac{AV_i \cdot ARF_i \cdot IDF_i \cdot GCF_i}{\sum_i \left(s_i \cdot AV_i \cdot ARF_i \cdot IDF_i \cdot GCF_i \right)} \right] \overline{P_s}$$

To redetermine the transfer amounts for plans in a given market area, the adjusted plan liability risk scores would be substituted for the original HHS-HCC values in the formula. All of the other factors would remain unchanged. Assuming that CMS would make the components of the plans' transfer calculations available to the State insurance department, the redetermination would be straightforward.

The table on the following page shows an illustration of the redetermination for a State with three participating plans.[12] Plans 1, 2, and 3 have Bronze, Silver, and Gold benefit plans, respectively, and attract members with average adult ages of 35, 40, and 45. The health status of the members varies, reflecting (in part) the level of coverage offered, with the three plans having illustrative plan liability risk scores of 0.600, 1.200, and 2.400, respectively, before adjustment for model estimation bias.

Based on the plans' HHS-HCC risk scores and actuarial values, the corresponding adjusted $PLRS_i$ scores are 0.653, 1.223, and 2.356, using the adjustment formula shown on page 8. Note that the adjusted risk scores for Plans 1 and 2 are adjusted upward, since their HHS-HCC predicted risk scores fall in the range where the model understates predicted expenditures. In contrast, there is a downward adjustment for Plan 3 (based on its higher predicted risk score). The adjustments improve the accuracy of each plan's risk score by removing the effect of the estimation bias from the HHS-HCC risk adjustment model.

Using the original, unadjusted HHS-HCC risk scores, Plan 1 would be assessed a risk adjustment charge of $154 PMPM, while Plans 2 and 3 would receive RA payments of $10 and $403, respectively. After substituting the adjusted plan liability risk scores into the transfer formula, the redetermined transfer amounts are –$138, $9, and $360. Plan 1 must still pay into the RA pool, reflecting its much healthier-than-average enrollees, but the amount is no longer overstated by the RA model estimation bias. Similarly, the adjusted receipts are still positive for Plans 2 and 3 but are not overstated by the bias. In both illustrations, the transfers sum to zero.

[12] Several simplifying assumptions have been made for convenience and ease of presentation. The State is assumed to have only one market rating area, the plans are assumed to be equally efficient, and each insurer is assumed to have only one plan in the State. In addition, the plans' distribution of enrollees by age category is assumed to match the national distribution.

Illustrative example of redetermination of risk adjustment transfers, based on adjusted HHS-HCC plan liability risk scores to remove model estimation bias

Factor	Plan 1	Plan 2	Plan 3	Weighted average
Predicted $PLRS_i$	0.600	1.200	2.400	1.140
Approximate predictive ratio	0.92	0.98	1.02	
Adjusted $PLRS_i$	0.653	1.223	2.356	1.165
AV_i	0.60	0.70	0.80	0.68
ARF_i	1.22	1.28	1.44	1.28
IDF_i	1.00	1.03	1.08	1.03
GCF_i	1.00	1.00	1.00	1.00
Enrollment	15,000	30,000	5,000	50,000*
Market share (s_i)	0.3	0.6	0.1	1.0*
$Premium_i$	$429	$516	$618	$500
Transfer calculation:				
Based on predicted $PLRS_i$				
Left-hand term of transfer formula	0.508	1.047	2.195	
Right-hand term of transfer formula	0.817	1.027	1.390	
Difference	–0.309	0.020	0.805	
Difference × P_s (equals PMPM transfer)	–$154	$10	$403	$0
Aggregate risk adjustment transfer	–$27.8 m	$3.6 m	$24.2 m	$0*
Based on adjusted $PLRS_i$				
Left-hand term of transfer formula	0.542	1.044	2.109	
Right-hand term of transfer formula	0.817	1.027	1.390	
Difference	–0.275	0.018	0.719	
Difference × P_s (equals PMPM transfer)	–$138	$9	$360	$0
Aggregate risk adjustment transfer	–$24.8 m	$3.2 m	$21.6 m	$0*

* Amount shown equals total for plans, not the weighted average.

Summary

Risk adjustment is critical to the successful operation of the individual and small group marketplaces under the Affordable Care Act. To be most effective, the risk adjustment process must be as accurate as possible, predicting average plan liability expenditure levels for a wide variety of plan categories and enrollee groups, with narrow standard errors and without estimation bias.

The plan liability risk scores predicted by the current HHS-HCC risk adjustment model are subject to an estimation bias that under-predicts scores for relatively healthy individuals and over-predicts them for people with chronic health conditions. If the insurers operating in a given State market area have memberships with relatively similar health profiles, then the estimation bias does not have a significant impact on the risk adjustment transfers among issuers. With significant differences in health status among plans, however, the estimation bias will generally overstate both the charges payable by plans with healthy enrollments and the transfer receipts for plans with less-healthy memberships.

The available evidence suggests that there is a considerable amount of enrollee risk selection by plan metal level and network breadth. As a result, it is likely that Bronze and Silver plans in the individual market typically have much lower risk scores than Gold and Platinum plans. Statewide average plan liability risk scores for Catastrophic plans in 2015 range from just 0.146 (Oregon) to 0.764 (Alabama), with an enrollment-weighted average of 0.340. Bronze plans, with a similar actuarial value to Catastrophic plans, may have correspondingly low average risk scores in the individual marketplaces. The Statewide average risk scores across Bronze, Silver, Gold, and Platinum plans in the individual market range from 1.344 (California) to 2.075 (Arizona), with a weighted average of 1.615. There are no data available breaking out the averages by metal level, unfortunately, but variation in plan risk scores is likely to be sufficient to result in significant understatements and overstatements due to estimation bias in the HHS-HCC model. While risk score variation in the small group market is likely to be less than in the individual market, there could still be significant impacts of estimation bias.

CMS is working to develop and implement a number of improvements in the HHS-HCC risk adjustment model. One such change will help address the issue of estimation bias, starting with plan year 2017. Other changes will further improve risk score accuracy starting in years 2018 and 2019.

In the meantime, a simple method exists to eliminate most or all of the estimation bias in predicted risk scores calculated using the current HHS-HCC risk adjustment model. The resulting adjusted risk scores could be used by State insurance departments to recalculate risk adjustment transfers for individual and small group health insurers for 2015 and 2016.

This note describes the issues and presents a practical approach for adjusting risk scores. The accuracy of the adjustments is tested, along with their sensitivity to underlying differences in the distribution of enrollment among adults, children, and infants. Finally, the paper illustrates the recalculation of risk adjustment transfers using a simplified, 3-plan example.

Please let me know if you have any questions about this methodology or would like to discuss its development and potential use.

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Consulting actuary

Appendix

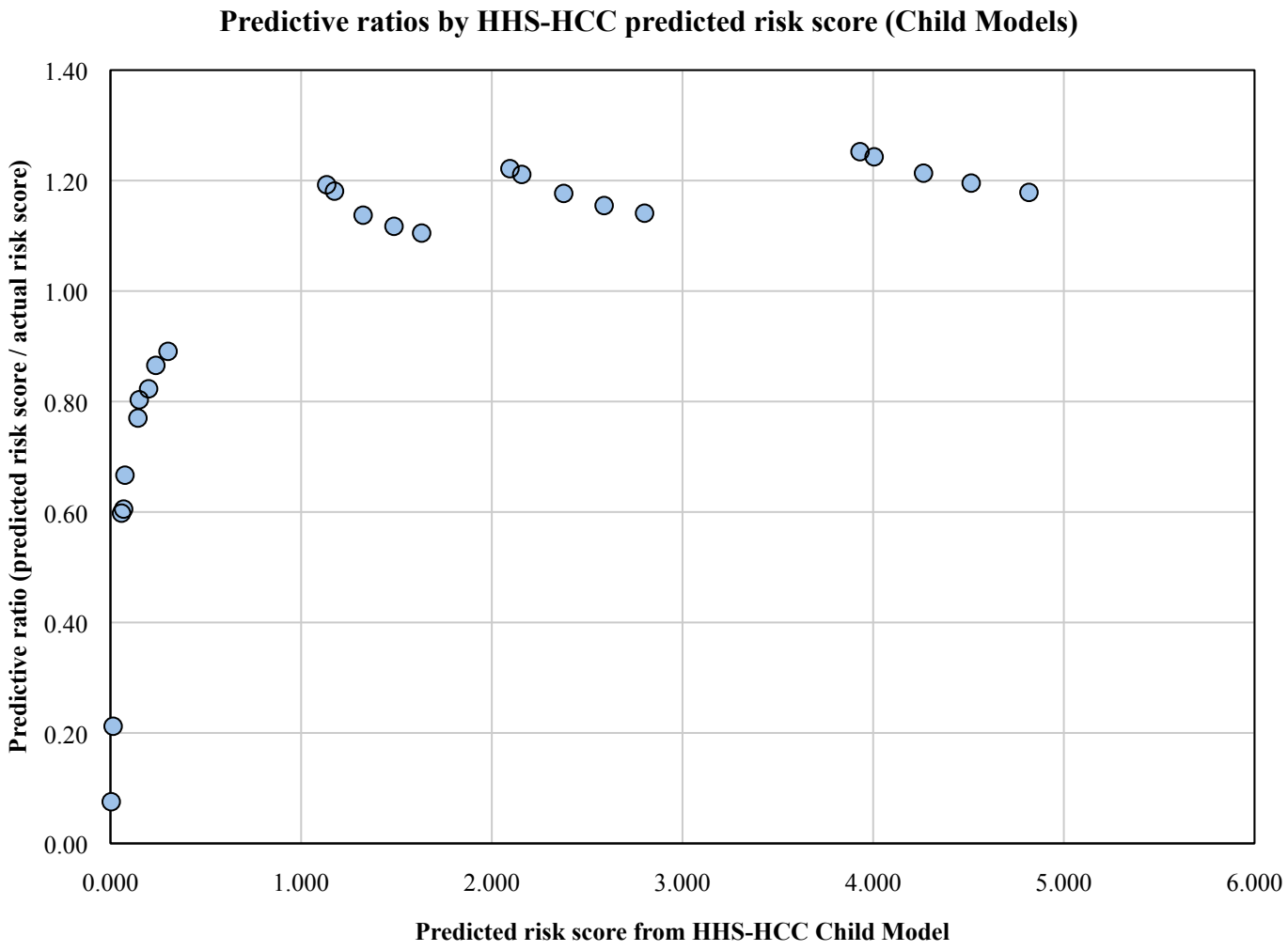
Tables and charts for predictive ratios and plan liability risk scores—Child RA Models

CMS Exhibit 8. Predictive Ratios by Percentiles of Predicted Expenditures—Child Models

	Percentiles (sorted by predicted $)					
	0–40%	**40–80%**	**80–100%**	**top 10%**	**top 5%**	**top 1%**
Platinum						
Predicted $	0.200	0.302	1.632	2.801	4.817	13.928
Actual $	0.243	0.339	1.477	2.455	4.087	11.049
Predictive Ratio	0.82	0.89	1.10	1.14	1.18	1.26
% of Overall Actual $	18.2	25.4	56.4	48.5	41.1	22.3
Gold						
Predicted $	0.144	0.238	1.487	2.589	4.514	13.467
Actual $	0.187	0.275	1.331	2.242	3.776	10.502
Predictive Ratio	0.77	0.87	1.12	1.15	1.20	1.28
% of Overall Actual $	16.4	24.1	59.5	51.8	44.4	24.9
Silver						
Predicted $	0.069	0.151	1.325	2.377	4.264	13.155
Actual $	0.114	0.188	1.165	2.020	3.514	10.176
Predictive Ratio	0.61	0.80	1.14	1.18	1.21	1.29
% of Overall Actual $	12.7	21.0	66.3	59.5	52.6	30.7
Bronze						
Predicted $	0.014	0.076	1.175	2.157	4.005	12.955
Actual $	0.066	0.114	0.995	1.781	3.222	9.955
Predictive Ratio	0.21	0.67	1.18	1.21	1.24	1.30
% of Overall Actual $	9.7	16.8	73.6	68.4	63.1	39.2
Catastrophic						
Predicted $	0.004	0.058	1.134	2.095	3.931	12.897
Actual $	0.053	0.097	0.951	1.715	3.139	9.889
Predictive Ratio	0.08	0.60	1.19	1.22	1.25	1.30
% of Overall Actual $	8.4	15.4	76.2	71.3	66.6	42.2

NOTES:
1. Predicted $ are mean relative predicted annualized plan liability expenditures for percentile group.
2. Actual $ are mean relative actual annualized plan liability expenditures for percentile group.
3. Predictive ratio is predicted $ divided by actual $.
4. % of overall actual $ is weighted sum of actual $ for percentile group divided by weighted sum of actual $ across entire adult sample, for each metal tier.
5. For a given model, percentiles are sorted by predicted $ for that model.
6. Children are ages 2-20.

SOURCE: Authors' analysis of 2010 MarketScan® Commercial Claims and Encounters Database.


Predictive ratios by HHS-HCC predicted risk score (Child Models)
Predictive ratio (predicted risk score / actual risk score)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.000
1.000
2.000
3.000
4.000
5.000
6.000
Predicted risk score from HHS-HCC Child Model

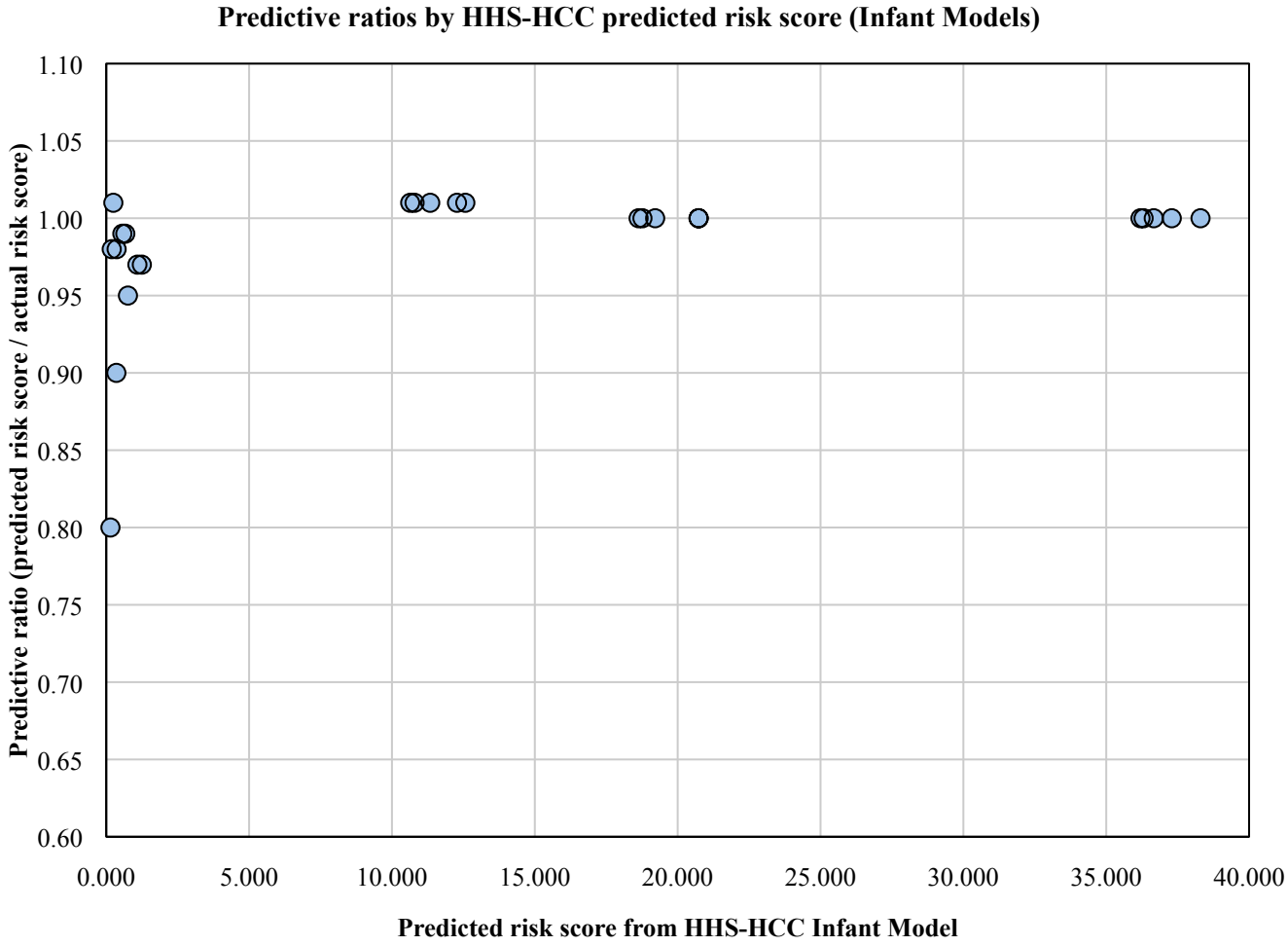
Tables and charts for predictive ratios and plan liability risk scores—Infant Models

CMS Exhibit 9. Predictive Ratios by Percentiles of Predicted Expenditures—Infant Models

	Percentiles (sorted by predicted $)					
	0–40%	**40–80%**	**80–100%**	**top 10%**	**top 5%**	**top 1%**
Platinum						
Predicted $	0.667	1.246	12.568	20.732	38.300	123.514
Actual $	0.675	1.281	12.461	20.738	38.209	123.716
Predictive Ratio	0.99	0.97	1.01	1.00	1.00	1.00
% of Overall Actual $	12.2	17.0	70.9	65.7	57.7	36.2
Gold						
Predicted $	0.563	1.090	12.276	20.732	37.294	122.116
Actual $	0.570	1.127	12.164	20.713	37.202	122.314
Predictive Ratio	0.99	0.97	1.01	1.00	1.00	1.00
% of Overall Actual $	11.0	16.2	72.8	67.9	60.3	38.5
Silver						
Predicted $	0.363	0.759	11.339	19.212	36.663	121.304
Actual $	0.369	0.797	11.232	19.209	36.571	121.500
Predictive Ratio	0.98	0.95	1.01	1.00	1.00	1.00
% of Overall Actual $	8.1	12.7	79.3	75.0	66.9	43.2
Bronze						
Predicted $	0.191	0.354	10.791	18.767	36.307	121.218
Actual $	0.194	0.392	10.695	18.765	36.218	121.415
Predictive Ratio	0.98	0.90	1.01	1.00	1.00	1.00
% of Overall Actual $	4.9	7.3	87.8	85.3	77.1	50.2
Catastrophic						
Predicted $	0.147	0.248	10.638	18.632	36.199	121.194
Actual $	0.183	0.247	10.546	18.629	36.113	121.391
Predictive Ratio	0.80	1.01	1.01	1.00	1.00	1.00
% of Overall Actual $	4.2	5.7	90.2	88.2	80.1	52.3

NOTES:
1. Predicted $ are mean relative predicted annualized plan liability expenditures for percentile group.
2. Actual $ are mean relative actual annualized plan liability expenditures for percentile group.
3. Predictive ratio is predicted $ divided by actual $.
4. % of overall actual $ is weighted sum of actual $ for percentile group divided by weighted sum of actual $ across entire adult sample, for each metal tier.
5. For a given model, percentiles are sorted by predicted $ for that model.
6. Infants are ages 0-1.

SOURCE: Authors' analysis of 2010 MarketScan® Commercial Claims and Encounters Database.


Predictive ratios by HHS-HCC predicted risk score (Infant Models)
Predictive ratio (predicted risk score / actual risk score)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
Predicted risk score from HHS-HCC Infant Model

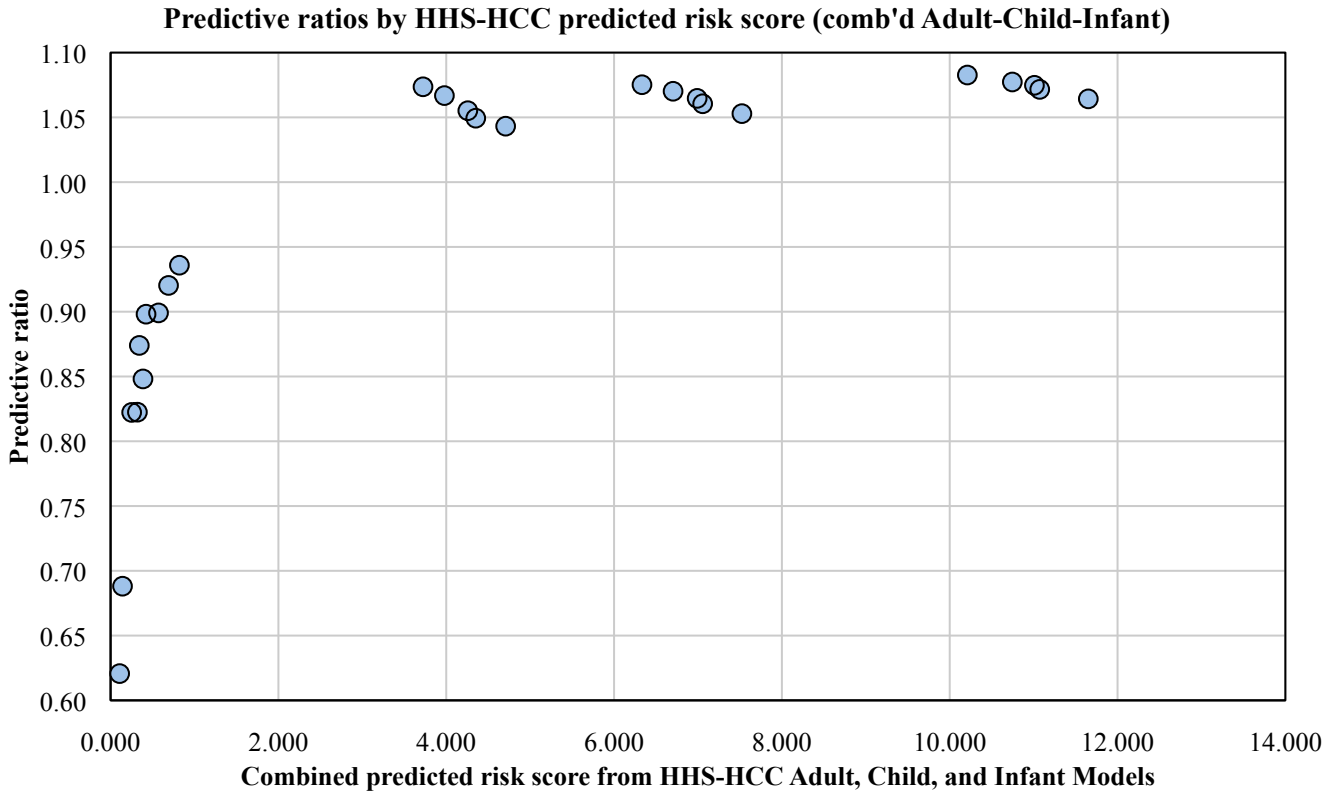
Tables and charts for predictive ratios and plan risk scores—Combined Adult, Child, and Infant

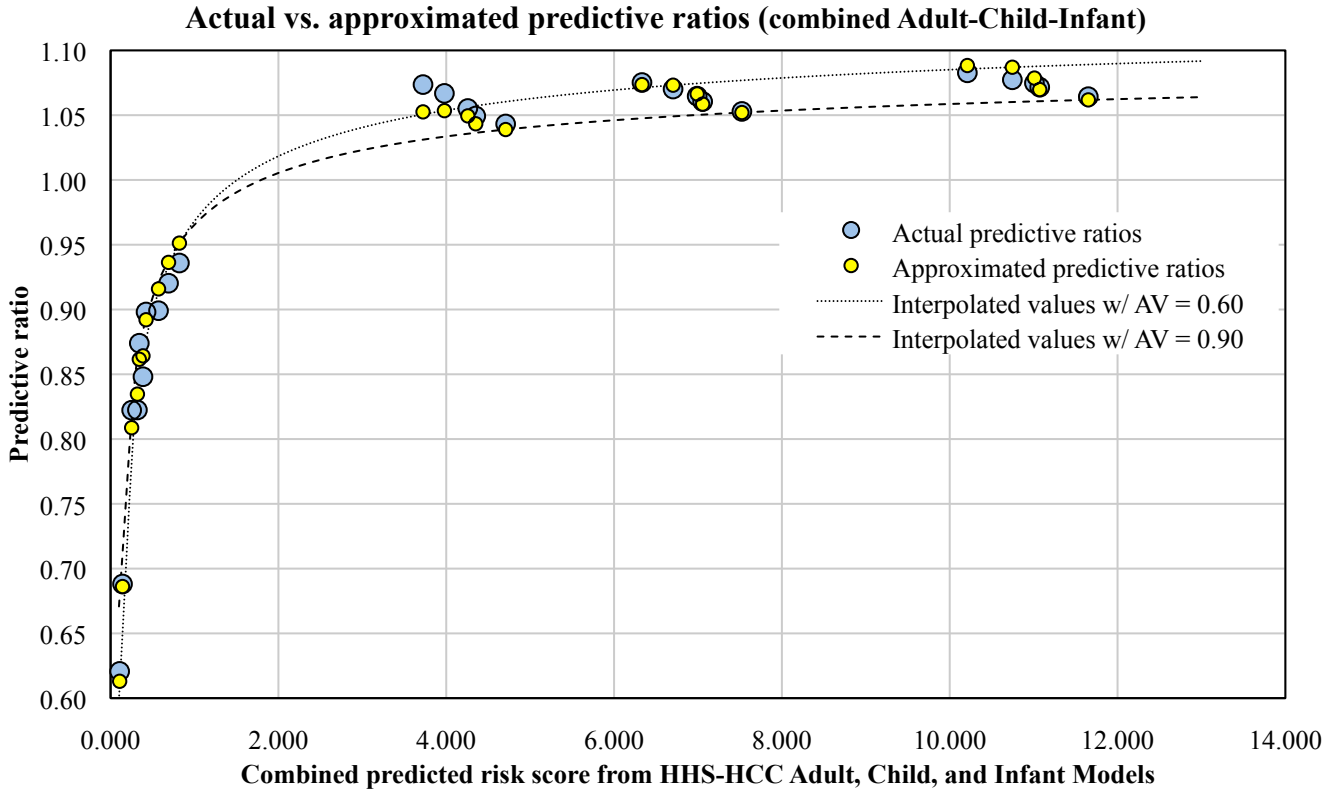
Weighted Plan Liability Risk Scores and corresponding predictive ratios—Combined Adult, Child, & Infant

	Percentiles (sorted by predicted $)				
	0–40%	**40–80%**	**80–100%**	**top 10%**	**top 5%**
Platinum					
Predicted $	0.423	0.820	4.708	7.523	11.652
Actual $	0.471	0.876	4.513	7.146	10.948
Predictive Ratio	0.90	0.94	1.04	1.05	1.06
Gold					
Predicted $	0.342	0.691	4.352	7.056	11.073
Actual $	0.392	0.751	4.147	6.653	10.333
Predictive Ratio	0.87	0.92	1.05	1.06	1.07
Silver					
Predicted $	0.251	0.571	4.257	6.990	11.009
Actual $	0.305	0.635	4.034	6.566	10.244
Predictive Ratio	0.82	0.90	1.06	1.06	1.07
Bronze					
Predicted $	0.142	0.386	3.978	6.703	10.746
Actual $	0.207	0.455	3.729	6.264	9.975
Predictive Ratio	0.69	0.85	1.07	1.07	1.08
Catastrophic					
Predicted $	0.108	0.320	3.723	6.333	10.210
Actual $	0.174	0.389	3.468	5.890	9.430
Predictive Ratio	0.62	0.82	1.07	1.08	1.08

See notes for CMS Exhibits.

SOURCE: Based on weighted plan liability risk scores for Adult, Child, and Infant HHS-HCC risk adjustment models from CMS Exhibits 7, 8, and 9. Weights based on 2016 national plan selection distribution by age group and metal level, for States using the HealthCare.gov Marketplace Platform.


Predictive ratios by HHS-HCC predicted risk score (comb'd Adult-Child-Infant)
Predictive ratio
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Combined predicted risk score from HHS-HCC Adult, Child, and Infant Models


Actual vs. approximated predictive ratios (combined Adult-Child-Infant)
Predictive ratio
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Combined predicted risk score from HHS-HCC Adult, Child, and Infant Models
Actual predictive ratios
Approximated predictive ratios
Interpolated values w/ AV = 0.60
Interpolated values w/ AV = 0.90

Comparison of predicted vs. adjusted HHS-HCC plan liability risk scores
(Combined Adult-Child-Infant; log scale used for clarity)