



HealthPartners®

# Total Cost of Care and Total Resource Use Bootstrap and Random Sample Reliability Analysis

*Using Johns Hopkins ACG Cell-Based Model*

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*The analysis and results included in this paper were reviewed and accepted by the National Quality Forum. Both measures were re-endorsed in September 2017.*

## **Purpose**

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Demonstrate the reliability of the Total Cost of Care Total Cost Index (TCI) and Resource Use Index (RUI) measures.

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## Overview of Analysis

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Total Cost of Care Total Cost Index (TCI) and Resource Use Index (RUI) are measures of a provider's effectiveness of managing their primary care attributed population across the care continuum. The TCI and RUI measures were applied to HealthPartners primary care providers as per the measure specifications and results were calculated for 2015.

The reliability testing demonstrates the repeatability of producing the same results a high proportion of the time. To measure the reliability of the TCI and RUI measures the actual results were compared to the results calculated by two sampling methods, bootstrapping and a 90% random sample.

These methods were chosen as they represent the measure intent, which is that the TCI and RUI measures represent providers' average total cost of care and resource use across their population. Since the measures are aggregated to the provider group level, evaluation of member level variability is not necessary.

In the bootstrapping method members that were attributed to a provider group were randomly selected with replacement. This method artificially creates variation around a provider group's total cost of care and resource use as each randomly selected iteration (sample populations) does not truly represent the provider's case mix of patients. What this method does however is give an indication as to the repeatability of the measure by comparing how closely the actual total cost and resource use measure are to the bootstrapped averages.

In the 90% random sample method, the members that were attributed to a provider group were randomly sampled at the 90% membership level without replacement. This technique was employed to create variation within a provider group by leveraging their own population and controlling for the patient case mix variation that is introduced when random sampling is employed.

## Overall Conclusions

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- The differences between the Actual TCI results and both the bootstrap and 90% sample results are very small ranging from -0.0059 to 0.0075 in the bootstrap to -0.0022 to 0.0012 in the 90% sample.
- The variances from Actual RUI ranged from -0.0036 to 0.0065 in the bootstrap to -0.0020 to 0.0015 in the 90% sample.
- The bootstrap results indicate that the TCIs and RUIs are reliable as the provider variation within all groups is <1% whereas the variation between groups spans >110%.

## Methodology

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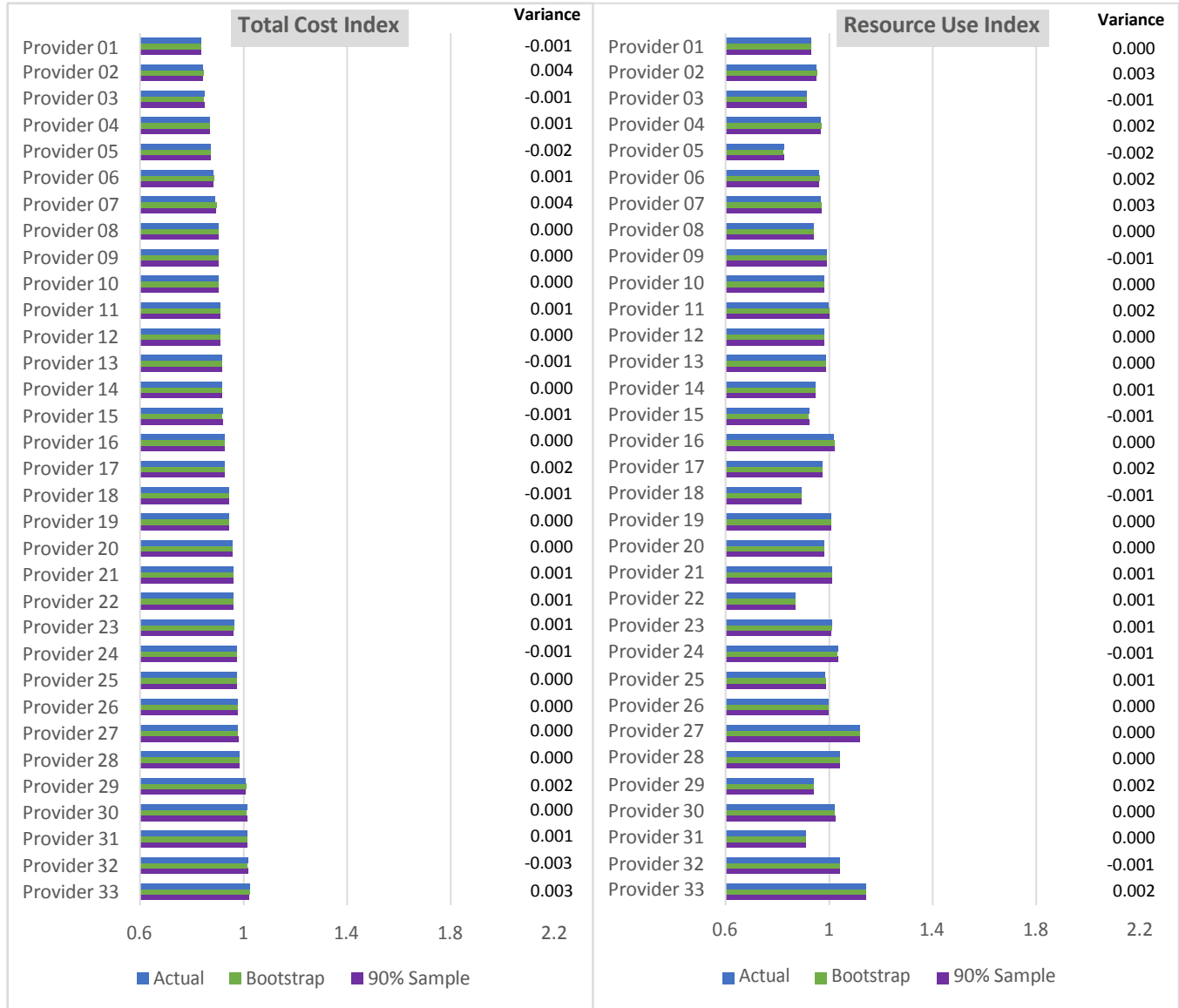
To perform the bootstrap, the SAS PROC SURVEYSELECT procedure with the Unrestricted Random Sample option for full replacement utilized to create a series of random samples for each provider group being measured. Full replacement means that one observation is drawn at random, recorded, and then placed back into the data pool so that it can be drawn again if randomly selected. The number of records sampled are drawn such that the samples created are the same size as the original number of attributed members for the provider group. In this way, it is theoretically possible (although virtually improbable) to produce a sample of size n that could consist of the same record drawn n times in a row. This sample process was performed 500 times for each provider group being analyzed, to produce 500 sets of risk-adjusted Total Cost of Care and Resource Use results for each provider (see figure 1 in the definitions section for more information).

Once the 500 samples were created for each provider group, the total costs of care and resource use of each sample for each provider group were compared to the network average to produce risk adjusted indices. The mean TCI from these 500 iterations was computed and compared to the Actual TCI and RUI indices for each provider group.

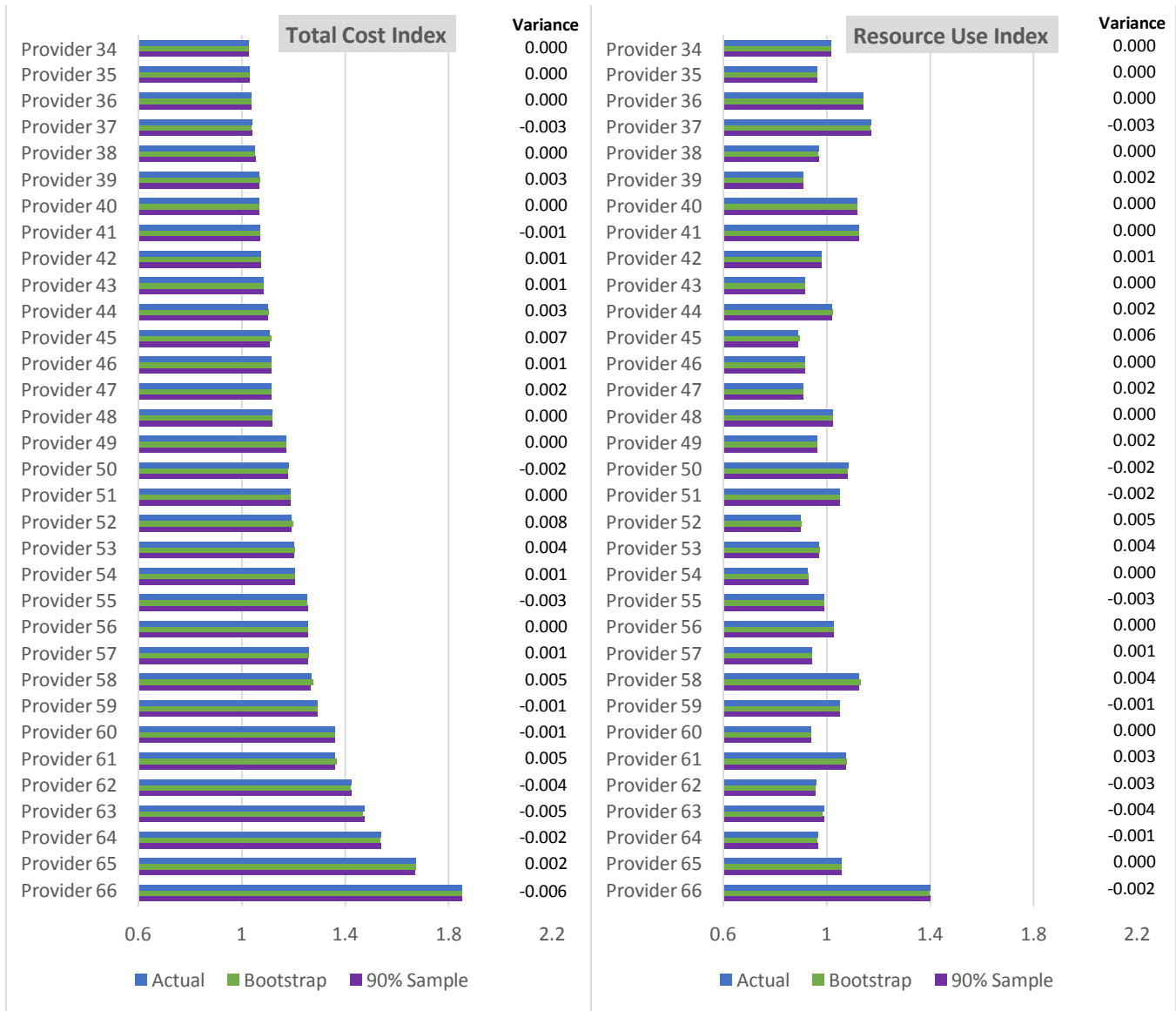
In the second method, 90% of attributed provider group members were randomly selected, without replacement. A 90% sample was used despite having the full health plan provider population, as a concession to provider claims that errors in administrative data may not allow for a perfect 100% representation of their population. The sampling process was performed using the SAS PROC SURVEYSELECT procedure with the Simple Random Sample (SRS) option. This method allows for each attributed member to be selected only one time until 90% of the total provider population has been reached. The 90% sampling process was repeated 500 times for each provider group. Attributed members' total costs and resource use were aggregated in each sample to produce 500 TCI results for each provider group (see figure 2 in the definitions section for more information). The mean of the sampled Total Cost and Resource Use indices was calculated for each provider group and compared to the Actual TCI and RUI indices for each provider group.

## Bootstrap and 90% Random Sample

The mean Total Cost Index and Resource Use results from the bootstrap and 90% samples compared to the actual TCI and RUI results for each provider group are displayed on the charts on the following pages. The **variance** between the actual TCI and RUI to the bootstrap results is shown on the far right of each chart. The TCI and RUI charts are sorted in ascending order by TCI. See [Appendix A](#) for detailed results.



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Definitions and Examples

Figure 1: Bootstrap Sampling – Unrestricted Random Sampling With Full Replacement

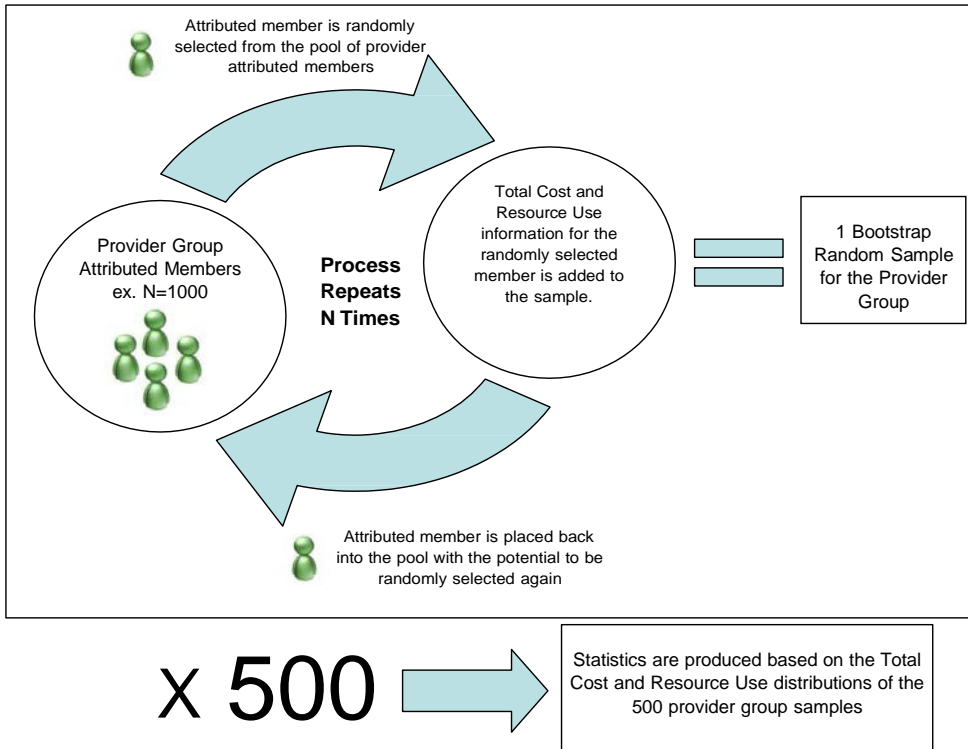
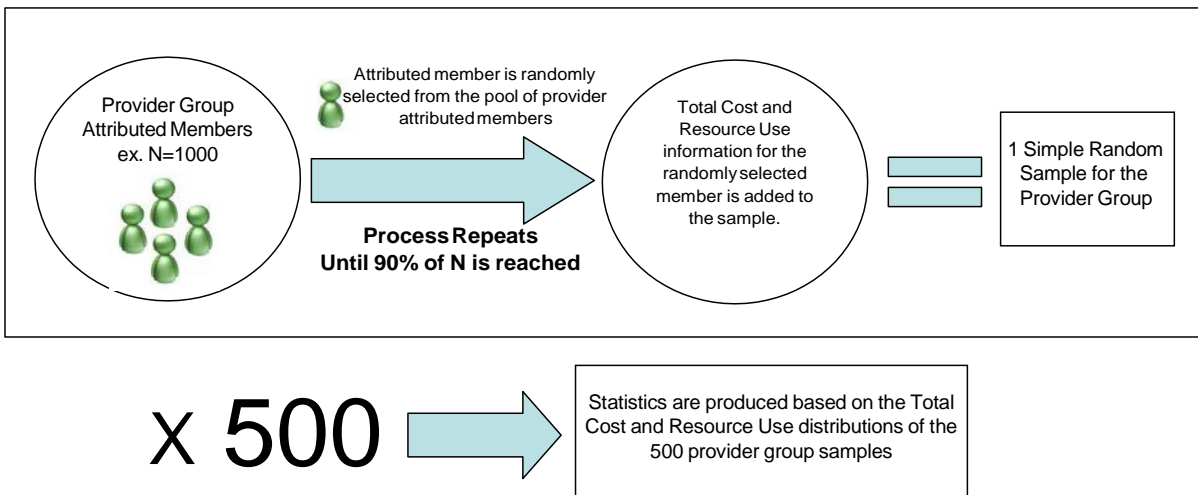


Figure 2: 90% Sampling – Simple Random Sample Without Replacement





**Appendix A: Bootstrap and 90% Random Sample Detail**

Provider Group	Total Cost Index					Resource Use Index				
	90% Sample	Bootstrap	Actual	Variation between Actual and Bootstrap	Variation between Actual and 90%	90% Sample	Bootstrap	Actual	Variation between Actual and Bootstrap	Variation between Actual and 90%
Provider 01	0.836	0.836	0.836	(0.001)	(0.000)	0.930	0.930	0.931	(0.000)	(0.000)
Provider 02	0.841	0.845	0.842	0.004	(0.001)	0.951	0.955	0.951	0.003	(0.001)
Provider 03	0.849	0.848	0.849	(0.001)	(0.000)	0.914	0.913	0.915	(0.001)	(0.000)
Provider 04	0.868	0.869	0.868	0.001	(0.000)	0.968	0.970	0.968	0.002	(0.000)
Provider 05	0.873	0.872	0.873	(0.002)	(0.001)	0.825	0.823	0.826	(0.002)	(0.001)
Provider 06	0.883	0.885	0.884	0.001	(0.001)	0.960	0.963	0.961	0.002	(0.001)
Provider 07	0.892	0.895	0.891	0.004	0.001	0.969	0.971	0.968	0.003	0.001
Provider 08	0.902	0.903	0.903	0.000	(0.000)	0.940	0.941	0.940	0.000	(0.000)
Provider 09	0.903	0.902	0.903	(0.000)	0.000	0.992	0.991	0.992	(0.001)	0.000
Provider 10	0.904	0.904	0.904	(0.000)	(0.000)	0.981	0.981	0.981	(0.000)	(0.000)
Provider 11	0.910	0.911	0.910	0.001	0.000	0.999	1.001	0.999	0.002	0.001
Provider 12	0.911	0.911	0.911	(0.000)	(0.000)	0.980	0.980	0.980	(0.000)	(0.000)
Provider 13	0.917	0.916	0.917	(0.001)	(0.000)	0.988	0.988	0.987	0.000	0.000
Provider 14	0.918	0.918	0.917	0.000	0.000	0.947	0.947	0.946	0.001	0.000
Provider 15	0.918	0.917	0.918	(0.001)	(0.000)	0.922	0.921	0.922	(0.001)	(0.000)
Provider 16	0.926	0.926	0.926	0.000	0.000	1.019	1.020	1.019	0.000	0.000
Provider 17	0.926	0.928	0.926	0.002	(0.000)	0.973	0.974	0.973	0.002	(0.000)
Provider 18	0.945	0.943	0.944	(0.001)	0.000	0.894	0.892	0.893	(0.001)	0.000
Provider 19	0.945	0.945	0.945	(0.000)	(0.000)	1.006	1.006	1.007	(0.000)	(0.000)
Provider 20	0.957	0.957	0.958	(0.000)	(0.000)	0.981	0.981	0.981	(0.000)	(0.000)
Provider 21	0.959	0.960	0.959	0.001	0.000	1.012	1.012	1.011	0.001	0.000
Provider 22	0.960	0.962	0.960	0.001	(0.000)	0.869	0.871	0.870	0.001	(0.001)
Provider 23	0.962	0.964	0.963	0.001	(0.001)	1.009	1.012	1.011	0.001	(0.002)
Provider 24	0.974	0.973	0.973	(0.001)	0.000	1.033	1.032	1.032	(0.001)	0.000
Provider 25	0.975	0.974	0.974	(0.000)	0.001	0.987	0.986	0.986	0.001	0.001
Provider 26	0.976	0.976	0.976	(0.000)	(0.000)	0.997	0.997	0.997	(0.000)	(0.000)
Provider 27	0.979	0.978	0.978	(0.000)	0.000	1.120	1.120	1.119	0.000	0.000
Provider 28	0.985	0.985	0.985	(0.000)	(0.000)	1.041	1.040	1.041	(0.000)	(0.000)
Provider 29	1.007	1.010	1.008	0.002	(0.000)	0.939	0.941	0.939	0.002	(0.000)
Provider 30	1.014	1.013	1.013	(0.000)	0.001	1.024	1.022	1.022	0.000	0.002
Provider 31	1.013	1.014	1.013	0.001	(0.000)	0.910	0.911	0.910	0.000	0.000
Provider 32	1.019	1.016	1.019	(0.003)	(0.000)	1.042	1.040	1.042	(0.001)	0.000
Provider 33	1.022	1.026	1.023	0.003	(0.001)	1.141	1.144	1.142	0.002	(0.001)
Provider 34	1.026	1.026	1.026	0.000	(0.000)	1.017	1.017	1.017	0.000	(0.000)
Provider 35	1.028	1.028	1.028	(0.000)	(0.000)	0.961	0.961	0.961	0.000	(0.000)
Provider 36	1.038	1.037	1.037	(0.000)	0.000	1.140	1.139	1.139	0.000	0.000
Provider 37	1.040	1.037	1.040	(0.003)	(0.000)	1.171	1.168	1.171	(0.003)	(0.000)
Provider 38	1.052	1.051	1.051	0.000	0.000	0.968	0.967	0.968	(0.000)	0.000
Provider 39	1.066	1.069	1.066	0.003	0.000	0.907	0.908	0.906	0.002	0.001
Provider 40	1.066	1.066	1.066	(0.000)	(0.000)	1.116	1.116	1.116	0.000	0.000
Provider 41	1.070	1.070	1.071	(0.001)	(0.000)	1.124	1.124	1.124	(0.000)	(0.000)
Provider 42	1.074	1.075	1.074	0.001	(0.001)	0.978	0.979	0.979	0.001	(0.000)
Provider 43	1.083	1.084	1.084	0.001	(0.001)	0.915	0.917	0.917	0.000	(0.001)
Provider 44	1.100	1.104	1.101	0.003	(0.001)	1.020	1.023	1.021	0.002	(0.001)
Provider 45	1.107	1.114	1.107	0.007	0.000	0.888	0.895	0.888	0.006	(0.000)
Provider 46	1.112	1.113	1.112	0.001	(0.000)	0.916	0.916	0.916	0.000	0.000
Provider 47	1.113	1.114	1.113	0.002	0.000	0.908	0.910	0.908	0.002	0.000
Provider 48	1.117	1.118	1.118	(0.000)	(0.001)	1.022	1.023	1.022	0.000	(0.001)
Provider 49	1.171	1.171	1.171	0.000	(0.000)	0.961	0.964	0.962	0.002	(0.001)
Provider 50	1.180	1.179	1.182	(0.002)	(0.002)	1.081	1.080	1.082	(0.002)	(0.001)
Provider 51	1.187	1.188	1.188	(0.000)	(0.001)	1.050	1.049	1.051	(0.002)	(0.000)
Provider 52	1.191	1.199	1.191	0.008	0.000	0.899	0.904	0.899	0.005	0.000
Provider 53	1.201	1.205	1.201	0.004	(0.000)	0.968	0.972	0.968	0.004	(0.000)
Provider 54	1.203	1.203	1.203	0.001	0.001	0.927	0.927	0.926	0.000	0.001
Provider 55	1.254	1.251	1.253	(0.003)	0.001	0.990	0.987	0.990	(0.003)	0.001
Provider 56	1.255	1.255	1.255	(0.000)	0.000	1.028	1.027	1.028	(0.000)	0.000
Provider 57	1.256	1.259	1.258	0.001	(0.001)	0.941	0.944	0.942	0.001	(0.001)
Provider 58	1.266	1.274	1.268	0.005	(0.002)	1.123	1.129	1.125	0.004	(0.002)
Provider 59	1.294	1.292	1.293	(0.001)	0.000	1.051	1.050	1.051	(0.001)	0.000
Provider 60	1.359	1.359	1.359	(0.001)	(0.000)	0.940	0.940	0.940	(0.000)	(0.000)
Provider 61	1.359	1.365	1.359	0.005	(0.001)	1.073	1.076	1.073	0.003	(0.001)
Provider 62	1.423	1.420	1.424	(0.004)	(0.001)	0.958	0.956	0.959	(0.003)	(0.001)
Provider 63	1.472	1.467	1.472	(0.005)	(0.000)	0.988	0.984	0.988	(0.004)	0.000
Provider 64	1.538	1.535	1.538	(0.002)	0.000	0.965	0.964	0.965	(0.001)	0.000
Provider 65	1.669	1.674	1.672	0.002	(0.002)	1.056	1.057	1.057	(0.000)	(0.002)
Provider 66	2.027	2.022	2.028	(0.006)	(0.000)	1.398	1.396	1.399	(0.002)	(0.000)