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Appendix Exhibit 1 Trends of Medicare spending geographic variation by care settings, measured by the differences in and ratios of price- and risk-adjusted per capita Medicare spending between high-cost and low-cost HRRs, 2007 - 2017

|      | Physician (\$) |       |       |       | Outpatient (\$) |       |       |       | Inpatient (\$) |       |       |       | Post-acute care (\$) |       |       |       | Hospice (\$) |     |       |       |
|------|----------------|-------|-------|-------|-----------------|-------|-------|-------|----------------|-------|-------|-------|----------------------|-------|-------|-------|--------------|-----|-------|-------|
|      | High           | Low   | Diff. | Ratio | High            | Low   | Diff. | Ratio | High           | Low   | Diff. | Ratio | High                 | Low   | Diff. | Ratio | High         | Low | Diff. | Ratio |
| 2007 | 3,653          | 2,673 | 980   | 1.37  | 1,168           | 1,200 | -32   | 0.97  | 3,247          | 2,631 | 616   | 1.23  | 2,573                | 1,030 | 1,542 | 2.50  | 389          | 192 | 197   | 2.03  |
| 2008 | 3,753          | 2,713 | 1,041 | 1.38  | 1,207           | 1,247 | -40   | 0.97  | 3,271          | 2,781 | 490   | 1.18  | 2,632                | 1,085 | 1,547 | 2.43  | 392          | 205 | 187   | 1.91  |
| 2009 | 3,895          | 2,802 | 1,093 | 1.39  | 1,374           | 1,389 | -15   | 0.99  | 3,336          | 2,776 | 560   | 1.20  | 2,931                | 1,208 | 1,723 | 2.43  | 411          | 209 | 203   | 1.97  |
| 2010 | 3,884          | 2,797 | 1,087 | 1.39  | 1,417           | 1,481 | -64   | 0.96  | 3,134          | 2,848 | 285   | 1.10  | 2,970                | 1,229 | 1,741 | 2.42  | 447          | 218 | 229   | 2.05  |
| 2011 | 3,734          | 2,752 | 983   | 1.36  | 1,417           | 1,458 | -41   | 0.97  | 2,948          | 2,583 | 365   | 1.14  | 2,914                | 1,220 | 1,694 | 2.39  | 435          | 224 | 210   | 1.94  |
| 2012 | 3,726          | 2,725 | 1,001 | 1.37  | 1,445           | 1,506 | -61   | 0.96  | 2,885          | 2,616 | 269   | 1.10  | 2,651                | 1,092 | 1,559 | 2.43  | 463          | 235 | 228   | 1.97  |
| 2013 | 3,725          | 2,717 | 1,008 | 1.37  | 1,438           | 1,514 | -76   | 0.95  | 2,811          | 2,515 | 295   | 1.12  | 2,566                | 1,164 | 1,402 | 2.20  | 444          | 241 | 203   | 1.84  |
| 2014 | 3,502          | 2,668 | 834   | 1.31  | 1,542           | 1,577 | -35   | 0.98  | 2,764          | 2,446 | 319   | 1.13  | 2,614                | 1,168 | 1,447 | 2.24  | 429          | 251 | 179   | 1.71  |
| 2015 | 3,636          | 2,798 | 838   | 1.30  | 1,667           | 1,668 | -1    | 1.00  | 2,804          | 2,459 | 344   | 1.14  | 2,531                | 1,198 | 1,334 | 2.11  | 425          | 250 | 175   | 1.70  |
| 2016 | 3,453          | 2,735 | 717   | 1.26  | 1,781           | 1,770 | 11    | 1.01  | 2,851          | 2,530 | 321   | 1.13  | 2,560                | 1,164 | 1,396 | 2.20  | 441          | 282 | 159   | 1.56  |
| 2017 | 3,510          | 2,709 | 802   | 1.30  | 1,856           | 1,853 | 3     | 1.00  | 2,818          | 2,521 | 297   | 1.12  | 2,436                | 1,118 | 1,318 | 2.18  | 475          | 279 | 197   | 1.71  |

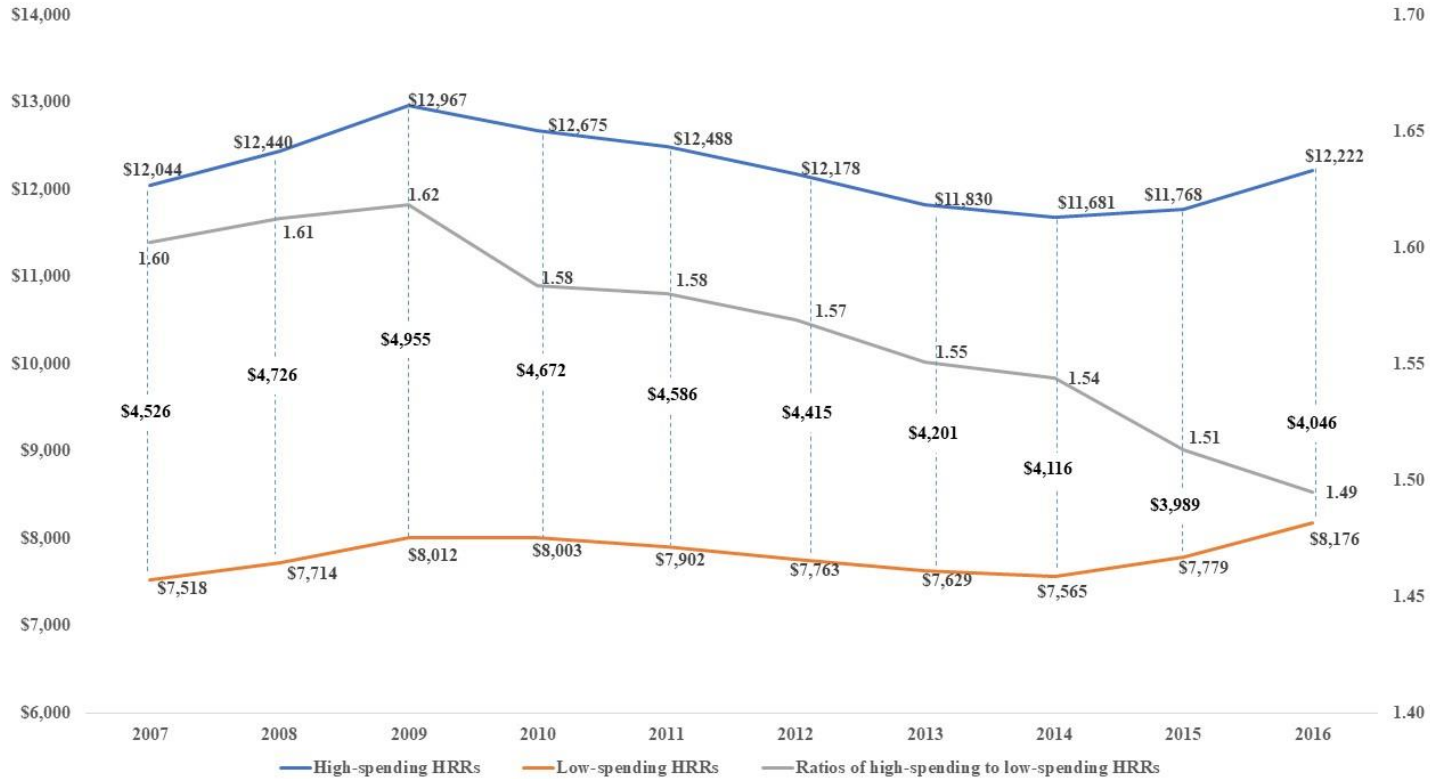
**SOURCE** Authors' analysis of data for 2007–2017 from the Medicare Geographic Variation Public Use File. **NOTES** High indicates high-spending HRRs that were in the top 10% of price- and risk-adjusted per capita total Medicare spending each year. Low indicates low-spending HRRs that were in the bottom 10% of price- and risk-adjusted per capita total Medicare spending each year. Physician costs include costs of all Part B services (e.g., evaluation & management and imaging). We also combined DME costs with physician costs due to the very small amount of per capita DME costs. Outpatient costs include hospital outpatient costs and outpatient dialysis facility costs. Inpatient costs include hospital inpatient costs; Post-acute care costs include long-term care hospital costs, inpatient rehabilitation costs, skilled nursing facility costs, and home health costs.

Appendix Exhibit 2 Characteristics of high- and low-spending HRRs at baseline of each subperiod

|   | High-spending HRRs |         |         | Low-spending HRRs |        |        | All HRRs |         |         |
|---|--------------------|---------|---------|-------------------|--------|--------|----------|---------|---------|
|   | 2007               | 2009    | 2014    | 2007              | 2009   | 2014   | 2007     | 2009    | 2014    |
| <b>Beneficiary characteristics</b>                                    |                    |         |         |                   |        |        |          |         |         |
| Average number of FFS beneficiaries                                   | 117,045            | 116,472 | 108,299 | 85,403            | 81,670 | 83,412 | 106,668  | 104,756 | 108,850 |
| Mean age  | 71.82              | 71.76   | 71.54   | 71.32             | 71.30  | 70.79  | 71.73    | 71.62   | 71.26   |
| Percent female  | 56.17              | 56.12   | 55.23   | 54.66             | 54.44  | 53.56  | 56.17    | 55.94   | 55.07   |
| Percent African American  | 14.02              | 14.26   | 13.10   | 4.23              | 4.00   | 5.07   | 9.39     | 9.57    | 9.70    |
| Percent Hispanic  | 8.03               | 8.56    | 7.93    | 7.77              | 8.39   | 10.62  | 5.09     | 5.41    | 5.61    |
| Percent dual-eligible patients  | 21.43              | 21.69   | 20.82   | 23.89             | 25.01  | 25.67  | 20.87    | 21.62   | 21.56   |
| Mean HCC score  | 1.04               | 1.04    | 1.04    | 0.94              | 0.93   | 0.94   | 0.98     | 0.98    | 0.98    |
| <b>Market characteristics</b>   |                    |         |         |                   |        |        |          |         |         |
| Percent average Medicare Advantage enrollment rate                    | 20.13              | 25.37   | 34.48   | 32.55             | 34.99  | 45.83  | 21.69    | 26.16   | 33.40   |
| Number of primary care physicians per 1,000 population                | 0.67               | 0.66    | 0.65    | 0.86              | 0.84   | 0.84   | 0.75     | 0.73    | 0.76    |
| Number of hospital beds per 1,000 population                          | 3.48               | 3.10    | 2.99    | 2.27              | 2.39   | 2.25   | 3.02     | 2.92    | 2.82    |
| Number of skilled nursing facility beds per 1,000 population          | 5.36               | 4.86    | 4.89    | 3.84              | 4.00   | 3.62   | 5.39     | 5.29    | 5.11    |
| Number of home health agencies per 1,000 population                   | 0.10               | 0.08    | 0.09    | 0.01              | 0.01   | 0.02   | 0.04     | 0.03    | 0.04    |
| Number of ambulatory surgery centers per 1,000 population             | 0.02               | 0.02    | 0.02    | 0.02              | 0.02   | 0.01   | 0.02     | 0.02    | 0.02    |
| Number of registered nurses employed by hospices per 1,000 population | 0.13               | 0.13    | 0.18    | 0.07              | 0.09   | 0.12   | 0.10     | 0.12    | 0.29    |

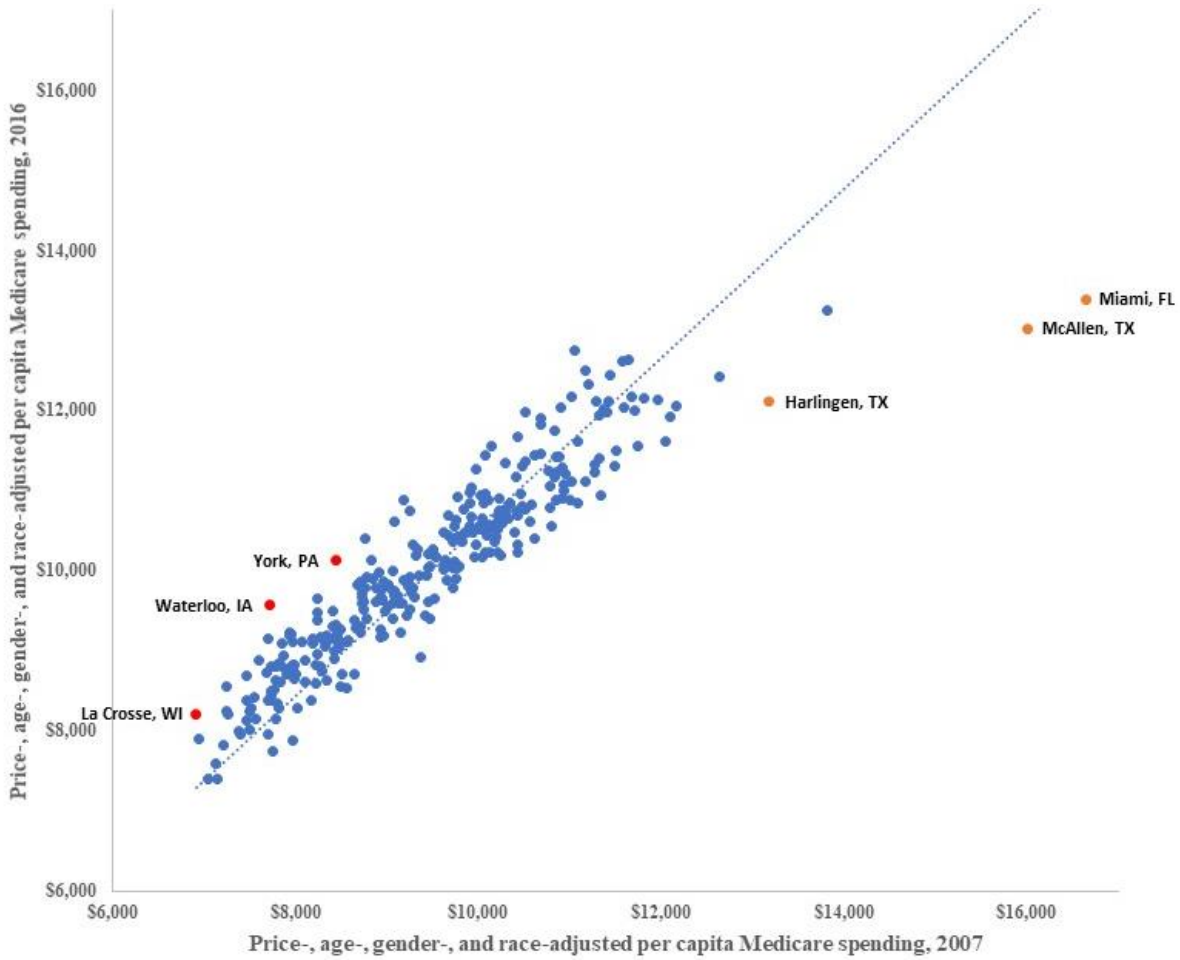
**SOURCE** Authors' analysis of data for 2007–2017 from the Medicare Geographic Variation Public Use File, Area Health Resource File, and Provider of Services File. **NOTES** High-spending HRRs were HRRs in the top 10% of price- and risk-adjusted per capita total Medicare spending each year. Low-spending HRRs were those in the bottom 10% of price- and risk-adjusted per capita total Medicare spending each year.

Appendix Exhibit 3 Trends of Medicare spending geographic variation, measured by the difference in and ratios of price-, age-, sex-, and race-adjusted per capita total Medicare spending between high-cost and low-cost HRRs using Dartmouth Atlas of Health Care data, 2007 - 2016



**SOURCE** Authors’ analysis of data for 2007–2016 from Dartmouth Atlas of Health Care. **NOTES** High-spending HRRs were in the top 10% of price-, age-, sex-, and race-adjusted per capita total Medicare spending each year. Low-spending HRRs were in the bottom 10% of price-, age-, sex-, and race-adjusted per capita total Medicare spending each year.

Appendix Exhibit 4 Relationship between 2007 and 2016 Medicare price-, age-, sex-, and race-adjusted per capita spending using Dartmouth Atlas of Health Care data



**SOURCE** Authors' analysis of data for 2007–2016 from Dartmouth Atlas of Health Care.

Appendix Exhibit 5 Trends of Medicare spending geographic variation by care settings, measured by the differences in and ratios of price-, age-, sex-, and race- adjusted per capita Medicare spending between high-cost and low-cost HRRs, using Dartmouth Atlas of Health Care data 2007 - 2016

|      | Physician (\$) |       |       |       | Outpatient (\$) |       |       |       | Inpatient and SNF (\$) |       |       |       | Home Health (\$) |     |       |       | Hospice (\$) |     |       |       |
|------|----------------|-------|-------|-------|-----------------|-------|-------|-------|------------------------|-------|-------|-------|------------------|-----|-------|-------|--------------|-----|-------|-------|
|      | High           | Low   | Diff. | Ratio | High            | Low   | Diff. | Ratio | High                   | Low   | Diff. | Ratio | High             | Low | Diff. | Ratio | High         | Low | Diff. | Ratio |
| 2007 | 3,574          | 2,359 | 1,215 | 1.52  | 1,129           | 1,011 | 118   | 1.12  | 5,538                  | 3,604 | 1,934 | 1.54  | 1,270            | 278 | 992   | 4.57  | 421          | 261 | 160   | 1.61  |
| 2008 | 3,680          | 2,304 | 1,376 | 1.60  | 1,203           | 1,118 | 85    | 1.08  | 5,604                  | 3,724 | 1,880 | 1.50  | 1,388            | 294 | 1,094 | 4.72  | 429          | 267 | 162   | 1.61  |
| 2009 | 3,876          | 2,361 | 1,515 | 1.64  | 1,265           | 1,243 | 22    | 1.02  | 5,860                  | 3,795 | 2,065 | 1.54  | 1,424            | 320 | 1,104 | 4.45  | 426          | 284 | 142   | 1.50  |
| 2010 | 3,849          | 2,308 | 1,541 | 1.67  | 1,199           | 1,296 | -97   | 0.93  | 5,792                  | 3,782 | 2,010 | 1.53  | 1,342            | 319 | 1,023 | 4.21  | 442          | 289 | 153   | 1.53  |
| 2011 | 3,825          | 2,320 | 1,505 | 1.65  | 1,198           | 1,298 | -100  | 0.92  | 5,735                  | 3,680 | 2,055 | 1.56  | 1,225            | 301 | 924   | 4.07  | 451          | 292 | 159   | 1.54  |
| 2012 | 3,776          | 2,273 | 1,503 | 1.66  | 1,310           | 1,375 | -65   | 0.95  | 5,456                  | 3,500 | 1,956 | 1.56  | 1,116            | 296 | 820   | 3.77  | 474          | 311 | 163   | 1.52  |
| 2013 | 3,592          | 2,200 | 1,392 | 1.63  | 1,429           | 1,488 | -59   | 0.96  | 5,216                  | 3,340 | 1,876 | 1.56  | 1,082            | 294 | 788   | 3.68  | 465          | 300 | 165   | 1.55  |
| 2014 | 3,529          | 2,215 | 1,314 | 1.59  | 1,506           | 1,504 | 2     | 1.00  | 5,119                  | 3,256 | 1,863 | 1.57  | 1,031            | 290 | 741   | 3.56  | 464          | 291 | 173   | 1.59  |
| 2015 | 3,593          | 2,312 | 1,281 | 1.55  | 1,551           | 1,571 | -20   | 0.99  | 5,103                  | 3,279 | 1,824 | 1.56  | 1,032            | 303 | 729   | 3.41  | 471          | 303 | 168   | 1.55  |
| 2016 | 3,678          | 2,325 | 1,353 | 1.58  | 1,655           | 1,726 | -71   | 0.96  | 5,388                  | 3,492 | 1,896 | 1.54  | 1,012            | 312 | 700   | 3.24  | 472          | 316 | 156   | 1.49  |

**SOURCE** Authors' analysis of data for 2007–2016 from Dartmouth Atlas of Health Care. **NOTES** High indicates high-spending HRRs that were in the top 10% of price-, age-, sex-, and race- adjusted per capita Medicare spending each year. Low indicates low-spending HRRs that were in the bottom 10% of price-, age-, sex-, and race- adjusted per capita Medicare spending each year. Dartmouth Atlas of Health Care used different categories for Medicare spending as compared to CMS data. We combined DME costs with physician costs due to the very small amount of per capita DME costs. SNF is skilled nursing facility.

Appendix Exhibit 6 Characteristics of high- and low-spending HRRs at baseline of each subperiod using Dartmouth Atlas of Health Care data, 2007 - 2016

|   | High-spending HRRs |         |         | Low-spending HRRs |        |        | All HRRs |         |         |
|---|--------------------|---------|---------|-------------------|--------|--------|----------|---------|---------|
|   | 2007               | 2009    | 2014    | 2007              | 2009   | 2014   | 2007     | 2009    | 2014    |
| <b>Beneficiary characteristics</b>                                    |                    |         |         |                   |        |        |          |         |         |
| Average number of FFS beneficiaries                                   | 99,844             | 116,855 | 119,316 | 66,022            | 60,703 | 82,552 | 106,668  | 104,756 | 108,850 |
| Mean age  | 71.98              | 71.82   | 71.43   | 71.74             | 71.50  | 71.19  | 71.73    | 71.62   | 71.26   |
| Percent female  | 56.33              | 56.07   | 55.39   | 54.31             | 53.92  | 53.21  | 56.17    | 55.94   | 55.07   |
| Percent African American  | 11.58              | 13.13   | 13.16   | 1.82              | 1.51   | 2.30   | 9.39     | 9.57    | 9.70    |
| Percent Hispanic  | 10.78              | 13.42   | 12.51   | 6.11              | 5.94   | 6.67   | 5.09     | 5.41    | 5.61    |
| Percent dual-eligible patients  | 21.90              | 26.97   | 24.95   | 19.58             | 19.98  | 20.64  | 20.87    | 21.62   | 21.56   |
| Mean HCC score  | 1.07               | 1.10    | 1.12    | 0.89              | 0.88   | 0.87   | 0.98     | 0.98    | 0.98    |
| <b>Supply-side characteristics</b>                                    |                    |         |         |                   |        |        |          |         |         |
| Percent average Medicare Advantage enrollment rate                    | 27.72              | 31.31   | 42.12   | 31.11             | 32.15  | 35.58  | 21.69    | 26.16   | 33.40   |
| Number of primary care physicians per 1,000 population                | 0.67               | 0.66    | 0.68    | 0.88              | 0.83   | 0.91   | 0.75     | 0.73    | 0.76    |
| Number of hospital beds per 1,000 population                          | 3.32               | 2.78    | 2.70    | 2.19              | 2.36   | 2.34   | 3.02     | 2.92    | 2.82    |
| Number of skilled nursing facility beds per 1,000 population          | 5.40               | 4.51    | 4.40    | 3.76              | 3.78   | 3.34   | 5.39     | 5.29    | 5.11    |
| Number of home health agencies per 1,000 population                   | 0.11               | 0.09    | 0.10    | 0.02              | 0.02   | 0.02   | 0.04     | 0.03    | 0.04    |
| Number of ambulatory surgery centers per 1,000 population             | 0.02               | 0.02    | 0.02    | 0.02              | 0.02   | 0.02   | 0.02     | 0.02    | 0.02    |
| Number of registered nurses employed by hospices per 1,000 population | 0.11               | 0.11    | 0.15    | 0.08              | 0.11   | 0.13   | 0.10     | 0.12    | 0.29    |

**SOURCE** Authors' analysis of data for 2007–2016 from the Dartmouth Atlas of Health Care, Area Health Resource file, and Provider of Services file. **NOTES** High-spending HRRs were those in the top 10% of price-, age-, sex-, and race-adjusted per capita total Medicare spending each year. Low-spending HRRs were those in the bottom 10% of price-, age-, sex-, and race-adjusted per capita total Medicare spending each year.

Appendix Exhibit 7 HRRs with the highest and lowest annual growth rate in price-, age-, sex-, and race-adjusted per capita Medicare spending between 2007 and 2016

|                                      | HRR name       | Deciles of Medicare per capita spending |      | Annual growth rate, % |
|--------------------------------------|----------------|---|------|-----------------------|
|                                      |                | 2007                                    | 2016 |                       |
|                                      |                |   |      |                       |
| Top 10 HRRs by Annual Growth Rate    | IA-Waterloo    | 1                                       | 4    | 2.4                   |
|                                      | PA-York        | 3                                       | 6    | 2.0                   |
|                                      | WI-La Crosse   | 1                                       | 1    | 1.9                   |
|                                      | CA-Ventura     | 4                                       | 6    | 1.9                   |
|                                      | NY-Binghamton  | 1                                       | 3    | 1.9                   |
|                                      | TX-Temple      | 5                                       | 8    | 1.9                   |
|                                      | SD-Rapid City  | 1                                       | 2    | 1.9                   |
|                                      | ID-Idaho Falls | 3                                       | 4    | 1.8                   |
|                                      | ID-Boise       | 1                                       | 2    | 1.7                   |
|                                      | IL-Urbana      | 5                                       | 7    | 1.7                   |
| Bottom 10 HRRs by Annual Growth Rate | FL-Miami       | 10                                      | 10   | -2.4                  |
|                                      | TX-McAllen     | 10                                      | 10   | -2.3                  |
|                                      | TX-Harlingen   | 10                                      | 10   | -0.9                  |
|                                      | LA-Monroe      | 10                                      | 10   | -0.5                  |
|                                      | CO-Boulder     | 5                                       | 2    | -0.5                  |
|                                      | LA-Lafayette   | 10                                      | 9    | -0.4                  |
|                                      | PA-Johnstown   | 10                                      | 8    | -0.4                  |
|                                      | LA-New Orleans | 9                                       | 7    | -0.3                  |
|                                      | LA-Houma       | 9                                       | 8    | -0.2                  |
|                                      | AL-Mobile      | 9                                       | 6    | -0.2                  |

**SOURCE** Authors' analysis of data for 2007–2016 from the Dartmouth Atlas of Health Care.



Appendix Exhibit 8 Association between baseline HRR characteristics and annual growth rate in price-, age-, sex-, and race- adjusted Medicare per capita spending using Dartmouth Atlas of Health Care data

|   | <b>2007-2009</b> |       | <b>2009-2014</b> |       | <b>2014-2016</b> |        |
|---|------------------|-------|------------------|-------|------------------|--------|
|   | Coefficients     | SE    | Coefficients     | SE    | Coefficients     | SE     |
| <b>Beneficiary characteristics</b>                                    |                  |       |                  |       |                  |        |
| Mean age  | 0.060            | 0.098 | 0.131 **         | 0.059 | -0.010           | 0.175  |
| Percent female  | -0.134 *         | 0.079 | 0.020            | 0.048 | -0.010           | 0.120  |
| Percent African American  | -0.009           | 0.018 | 0.003            | 0.008 | -0.001           | 0.013  |
| Percent Hispanic  | -0.031 **        | 0.015 | -0.004           | 0.010 | 0.003            | 0.021  |
| Percent dual-eligible patients  | -0.018           | 0.016 | -0.002           | 0.013 | 0.055            | 0.041  |
| Mean HCC score  | 5.55 ***         | 1.743 | -1.571 *         | 0.820 | -9.394 ****      | 1.858  |
| <b>Market characteristics</b>   |                  |       |                  |       |                  |        |
| Percent average Medicare Advantage enrollment rate                    | -0.001           | 0.009 | -0.002           | 0.005 | 0.014            | 0.010  |
| Number of primary care physicians per 1,000 population                | -0.300           | 0.615 | -0.791           | 0.485 | 0.102            | 0.926  |
| Number of hospital beds per 1,000 population                          | -0.044           | 0.089 | 0.077            | 0.065 | -0.116           | 0.170  |
| Number of skilled nursing facility beds per 1,000 population          | -0.081           | 0.052 | 0.018            | 0.032 | 0.015            | 0.088  |
| Number of home health agencies per 1,000 population                   | 1.384            | 2.726 | -9.256 ***       | 3.458 | 3.966            | 3.936  |
| Number of ambulatory surgery centers per 1,000 population             | 8.276            | 8.345 | -9.354 **        | 4.234 | 14.061           | 11.635 |
| Number of registered nurses employed by hospices per 1,000 population | -1.235           | 1.271 | -0.671           | 0.460 | -0.058 ****      | 0.013  |
| <b>Number of observations</b>   | 306              |       | 306              |       | 306              |        |

**SOURCE** Authors' analysis of data for 2007–2016 from the Dartmouth Atlas of Health Care, Area Health Resource file, and Provider of Services file. **NOTES** MA is Medicare Advantage; HCC is Hierarchical Condition Category. \*  $P < 0.10$ , \*\*  $P < 0.05$ , \*\*\*  $P < 0.01$ , \*\*\*\*  $P < 0.001$ .