Supplemental Materials for *Medicare Advantage Enrollment and Beneficiary Risk Scores: Difference-in-Differences Analyses Show Increases for All Enrollees On Account of Market-Wide Changes*

These supplemental materials provide additional information on robustness checks for the article, *Medicare Advantage Enrollment and Beneficiary Risk Scores: Difference-in-Differences Analyses Show Increases for All Enrollees On Account of Market-Wide Changes*. Specifically, we report the results of four additional robustness checks beyond those that were reported in the main article. Those checks include one model that replicated the approach used by MedPAC, one model that replaces MA duration with insurer duration, a test for pre-switch differences between switchers and stayers, and limiting the analysis to beneficiaries who moved from one state to another state. We also report the results for the same analysis in a later study period and an additional specification that evaluates whether coding intensity differs across plan type.

**Replicating MedPAC’s Analysis**

First, we replicated the approach used by MedPAC (2016). That analysis also compared risk score growth between switchers and stayers, but differed from ours in a key regard. The MedPAC analysis allowed the effect of **switching** from FFS to MA to change over time but it did not allow the effect of **enrollment** in MA to change over time (as ours does). For that reason, Equation S1 replaces the enrollment year terms from Equation 1 with indicators for the year in which beneficiaries switched into MA.

\[
(S1) \quad Risk_{it} = \gamma_0 + \gamma_1(MA_{it} \times Switch09_{i}) + \gamma_2(MA_{it} \times Switch10_{i}) \\
+ \gamma_3(MA_{it} \times Switch11_{i}) + \gamma_4(MA_{it} \times Switch12_{i}) \\
+ \gamma_5(YearsPostSwitch_{it}) + \gamma_6(X_{it}) + \gamma_7(I_{i}) + \gamma_8(Y_{t}) + \epsilon_{it}
\]

In Equation S1, \(MA_{it} \times Switch_{i}y_{i}\) represents a vector of interaction terms between indicators for each switch-year cohort (2009, 2010, 2011, and 2012) and MA enrollment. Those switch cohort terms represent the effect on beneficiaries’ risk scores of switching to MA in a given year. This approach assumes that the effect of **switching** to MA varies over time, whereas the enrollment year terms in the main text equations 1 and 2 allow the effect of **being enrolled** in MA to vary over time. If the program-wide effect of enrollment in MA does vary by year, however, then the enrollment duration would capture any increases in coding intensity that occur for all MA enrollees as a function of time. Consequently, we hypothesize that the coefficient on the enrollment duration term in Equation S1 will be higher than the coefficients on the enrollment duration term in Equation 1 in the main text. The difference between the two coefficients reflects the difference between time-varying effects of **switching to MA** versus **being enrolled in MA**. Consistent with that hypothesis, the coefficient for enrollment duration in Equation S1 is 67 percent larger than the coefficient for enrollment duration in Equation 1 from the main text (see Table S1).
### Table S1. Regression Results for Equation S1

| Model                                      | Equation S1. Switch Year + Enrollment Duration |
|--------------------------------------------|-----------------------------------------------|
| Years in MA since switch                   | 0.020 ***                                     |
|                                             | (68.5)                                        |
| **Switched to MA in:**                     |                                               |
| 2009                                       | 0.051 ***                                     |
|                                             | (51.9)                                        |
| 2010                                       | 0.065 ***                                     |
|                                             | (80.9)                                        |
| 2011                                       | 0.083 ***                                     |
|                                             | (90.8)                                        |
| 2012                                       | 0.072 ***                                     |
|                                             | (77.5)                                        |
| MA Penetration Rate                        | 0.061 ***                                     |
|                                             | (28.6)                                        |
| Eligible for Full Medicaid Benefits        | 0.507 ***                                     |
|                                             | (780.8)                                       |
| Eligible for Partial Medicaid Benefits     | 0.295 ***                                     |
|                                             | (416.8)                                       |
| Institutionalized for Six Months or Longer  | 0.087 ***                                     |
|                                             | (90.6)                                        |
| Number of Observations                     | 116,101,120                                   |
| R-Squared                                  | 0.668                                         |
| Individual Fixed Effects                   | Yes                                           |
| Year Fixed Effects                         | Yes                                           |

Source: Authors’ analysis of Medicare beneficiary summary file and risk adjustment data, 2008 - 2013. T-values in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.10

### Further Tests for Selection Bias

Although the analysis controls for beneficiaries’ risk prior to switching, selection bias could be present if switchers enrolled in MA because they anticipated a future change in health status or if switchers’ risk scores were growing differently than stayers even before the switch. To address those concerns, we first test for pre-switch differences between stayers and switchers by adding two pre-switch indicators to equation (2) to check for
differences in pre-existing trends between stayers and switchers. Pre-switch indicators equal 1 for switchers 1 or 2 years before the switch and equal zero otherwise; pre-switch indicators always equal zero for stayers. We also tested the pre-switch trends assumption using the same model but excluding 2009 and 2010 switchers (because they did not have a full set of pre-switch trends) and using three similar models that only include the years of data prior to the switch (one model for 2010 switchers, one for 2011 switchers, and one for 2012 switchers).

The coefficients on both indicators were negative and statistically significant, suggesting that switchers’ risk scores were growing more slowly than stayers’ risk scores before they switched to MA. Two years before the switch, switcher risk scores grew 0.7 percent less than stayers. One year before the switch, switcher risk scores grew 1.0 percent less than stayers (see Table S2). The difference between the two years—0.3 percent—is quite small but potentially indicates slower growth in risk scores among future switchers compared to stayers. That finding is consistent with the possibility of favorable selection, which would tend to bias our results towards zero. We obtained similar results from the models that exclude 2009 and 2010 switchers and from the models that only include the years of data prior to the switch.¹

Next, we limited the analysis to stayers who moved from one state to another state during the study period and switchers who moved at least one year prior to their switch. Moving from one state to another prompts a plausibly exogenous reason to switch for two reasons: first, there will most likely be a different selection of health plans available in a different state, and second, beneficiaries will already need to identify new health care providers so they may be less concerned with whether their long-term provider is part of MA plans’ networks.

Consistent with main results, that analysis also found larger increases in risk scores among switchers compared to stayers (see Table S2). This is an imperfect test for selection because people may have moved as the result of an adverse health event—to receive specialized treatment or to be close to a family caregiver, for example. Note, however, that the limitation would only affect our results if switchers moved as the result of adverse health more frequently than did stayers. Further, the analysis of movers yielded similar results to our primary specification. Repeating that analysis with pre-switch interaction terms suggests that in the years prior to the switch, switchers who relocated had lower risk scores and slower growth in risk scores than did stayers who relocated.

¹ Results are available from the authors.
### Table S2. Regression Results for Specification Tests

| Model                          | Pre-Switch Indicators | Movers Only Main Results | Movers Only, Pre-Switch Indicators |
|-------------------------------|-----------------------|--------------------------|-----------------------------------|
| 2 years before switch         | -0.007 ***            |                          | -0.017 ***                        |
|                               | (9.4)                 |                          | (4.9)                             |
| 1 year before switch          | -0.010 ***            |                          | -0.022 ***                        |
|                               | (12.7)                |                          | (6.3)                             |
| Enrolled in MA in:            |                       |                          |                                   |
| 2009                          | 0.043 ***             | 0.076 ***                | 0.053 ***                         |
|                               | (33.0)                | (9.7)                    | (6.2)                             |
| 2010                          | 0.058 ***             | 0.075 ***                | 0.056 ***                         |
|                               | (60.2)                | (16.2)                   | (10.1)                            |
| 2011                          | 0.064 ***             | 0.067 ***                | 0.052 ***                         |
|                               | (75.0)                | (18.4)                   | (12.3)                            |
| 2012                          | 0.076 ***             | 0.080 ***                | 0.071 ***                         |
|                               | (88.6)                | (22.5)                   | (18.3)                            |
| Years in MA since switch      | 0.010***              | 0.013***                 | 0.008***                          |
|                               | (21.9)                | (5.2)                    | (3.2)                             |
| MA Penetration Rate           | 0.062 ***             | 0.106 ***                | 0.107 ***                         |
|                               | (28.9)                | (26.2)                   | (26.4)                            |
| Eligible for Full Medicaid Benefits | 0.507 ***          | 0.451 ***                | 0.451 ***                         |
|                               | (780.8)               | (186.4)                  | (186.4)                           |
| Eligible for Partial Medicaid Benefits | 0.295 ***           | 0.304 ***                | 0.304 ***                         |
|                               | (416.9)               | (111.6)                  | (111.6)                           |
| Institutionalized for Six Months or Longer | 0.087 ***      | 0.056 ***                | 0.056 ***                         |
|                               | (90.6)                | (14.4)                   | (14.3)                            |
| Number of Observations        | 116,101,120           | 4,706,945                | 4,706,945                         |
| R-Squared                     | 0.668                 | 0.647                    | 0.647                             |
| Individual Fixed Effects      | Yes                   | Yes                      | Yes                               |
| Year Fixed Effects            | Yes                   | Yes                      | Yes                               |

Source: Authors' analysis of Medicare beneficiary summary file and risk adjustment data, 2008 - 2013. T-values in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.10
Additional Analysis of Insurer Duration

Next, we estimated a model similar to equation 1 in the main text that replaced length of MA enrollment with length of enrollment with a particular insurer. That allowed us to compare the magnitude of the two effects absent any concerns of collinearity between the two duration measures. Therefore, Equation S2 is identical to Equation 1 other than replacing the MA duration term with a term that represents insurer duration.

\[
(S2) \quad Risk_{it} = \beta_0 + \beta_1(MA_{it} \times I09_{it}) + \beta_2(MA_{it} \times I10_{it}) + \beta_3(MA_{it} \times I11_{it}) \\
+ \beta_4(MA_{it} \times I12_{it}) + \beta_5(YearsPostSwitch_{Ins_{it}}) + \beta_6(X_{it}) + \beta_7(I_{it}) \\
+ \beta_8(Y_{it}) + \epsilon_{it}
\]

The results from this model (see Table S3) are very similar to the main results reported in Table 1, though the magnitude and T-value for the insurer duration term (0.010 and 23.2, respectively) are somewhat smaller than the magnitude and T-value for the MA duration term (0.012 and 28.6).

| Table S3. Regression Results for Equation S2 |
|---------------------------------------------|
| **Model** | **Equation S2. Enrollment Year + Insurer Duration** |
| Enrolled in MA in: | |
| 2009 | 0.049 *** |
| | (48.9) |
| 2010 | 0.066 *** |
| | (93.4) |
| 2011 | 0.073 *** |
| | (109.8) |
| 2012 | 0.086 *** |
| | (120.5) |
| Years since switching to current insurer | 0.010 *** |
| | (23.2) |
| MA Penetration Rate | 0.061 *** |
| | (28.7) |
| Eligible for Full Medicaid Benefits | 0.507 *** |
| | (78.8) |
| Eligible for Partial Medicaid Benefits | 0.295 *** |
| | (416.9) |
| Institutionalized for Six Months or Longer | 0.087 *** |
| | (90.6) |
| Number of Observations | 116,101,120 |
| R-Squared | 0.668 |
| Individual Fixed Effects | Yes |
| Year Fixed Effects | Yes |

Source: Authors' analysis of Medicare beneficiary summary file and risk adjustment data, 2008 - 2013. T-values in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.10
Replicating the Analysis for a 2010-2014 Study Period

Here, we replicated our study methodology for a later time period to test whether the effects of MA enrollment on coding intensity continue beyond 2012. As discussed in the main text, this is not a perfectly consistent analysis of risk scores because CMS began phasing in a new risk adjustment model in 2014. While we continue to use risk scores from the prior model throughout this later study period, insurers’ coding incentives may have changed slightly because of the new model. Results from this later study period show that the effect of MA enrollment on coding intensity continued to increase over time (See Table S4).

Table S4: Regression Results for 2010-2014 panel

| Model | Equation 1. Enrollment Year + Enrollment Duration | Count of Low-Variable Conditions | Acute Myocardial Infarction |
|-------|---------------------------------------------------|---------------------------------|-----------------------------|
| Enrolled in MA in: | | | |
| 2011 | 0.067*** | -0.004*** | 0.000 |
| | (61.8) | (8.5) | (1.2) |
| 2012 | 0.081*** | 0.000 | 0.000 |
| | (112.9) | (0.9) | (1.2) |
| 2013 | 0.100*** | 0.000 | 0.000*** |
| | (160.4) | (1.4) | (3.7) |
| 2014 | 0.114*** | 0.000 | 0.000** |
| | (164.5) | (1.4) | (2.2) |
| Years in MA since switch | 0.020*** | 0.001*** | -0.000** |
| | (49.9) | (2.9) | (2.5) |
| MA Penetration Rate | 0.110*** | 0.013*** | 0.003*** |
| | (51.6) | (14.5) | (10.5) |
| Eligible for Full Medicaid Benefits | 0.516*** | 0.053*** | 0.008*** |
| | (776.6) | (191.6) | (87.1) |
| Eligible for Partial Medicaid Benefits | 0.306*** | 0.023*** | 0.004*** |
| | (426.9) | (77.3) | (37.5) |
| Institutionalized for Six Months or Longer | 0.088*** | -0.033*** | -0.011*** |
| | (89.5) | (79.7) | (73.3) |
| Number of Observations | 117,611,455 | 117,611,455 | 117,611,455 |
| R-Squared | 0.678 | | 0.248 |
| Individual Fixed Effects | Yes | Yes | Yes |
| Year Fixed Effects | Yes | Yes | Yes |

Source: Authors' analysis of Medicare beneficiary summary file and risk adjustment data, 2010 - 2015.

T-values in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.10
Incorporating Plan-Type Interactions

Finally, we tested whether coding intensity differences vary by plan type. In this model, we interacted our treatment variables with indicators for enrollment in HMOs, PPOs, and PFFS plan types. Results from this model show that enrollment in HMO plans is associated with greater increases in coding intensity, which is consistent with the idea that provider-level mechanisms play a large role in coding intensity differences because HMO plan types tend to have stronger provider relationships than other plan types. Similarly, enrollment in PFFS plans is generally associated with less coding intensity, although patterns over time for those and the PPO interaction terms may be confounded by the PFFS plan cancellations discussed in the main text. For that reason, we repeated this analysis for the 2011-2014 study period. Like for the earlier study period, we found that enrollment in HMO plans is associated with greater coding intensity, and enrollment in PFFS plans is associated with less coding intensity. However, in the later study period, coding intensity increases over time for all plan types and the MA duration interaction terms follow a similar pattern as the annual effects in that the MA duration effect is strongest among those enrolled in HMO plans and weakest among those enrolled in PFFS plans (See Table S5). Additional unreported analyses confirm that the plan-type interaction terms are statistically different across plan types. Demographic and county-level control variables are excluded from these tables because of space considerations. Those coefficients and t-values are consistent with prior models and full results are available from the authors upon request.
|                                | 2008-2012 study period          | 2010-2014 study period          |
|--------------------------------|---------------------------------|---------------------------------|
| **Enrolled in an HMO plan**    | Enrolled in MA in:              | Enrolled in MA in:              |
|                                | 2009                            | 2011                            |
|                                | 0.065***                        | 0.079***                        |
|                                | (44.2)                          | (52.1)                          |
|                                | 2010                            | 2012                            |
|                                | 0.083***                        | 0.093***                        |
|                                | (79.4)                          | (94.7)                          |
|                                | 2011                            | 2013                            |
|                                | 0.084***                        | 0.113***                        |
|                                | (86.3)                          | (128.6)                         |
|                                | 2012                            | 2014                            |
|                                | 0.094***                        | 0.125***                        |
|                                | (87.5)                          | (123.7)                         |
|                                | HMO*Years in MA since switch    | HMO*Years in MA since switch    |
|                                | 0.020***                        | 0.032***                        |
|                                | (35.0)                          | (55.8)                          |
| **Enrolled in a PPO plan**     | Enrolled in MA in:              | Enrolled in MA in:              |
|                                | 2009                            | 2011                            |
|                                | 0.050***                        | 0.055***                        |
|                                | (26.7)                          | (37.0)                          |
|                                | 2010                            | 2012                            |
|                                | 0.064***                        | 0.071***                        |
|                                | (56.0)                          | (69.4)                          |
|                                | 2011                            | 2013                            |
|                                | 0.062***                        | 0.089***                        |
|                                | (61.1)                          | (100.7)                         |
|                                | 2012                            | 2014                            |
|                                | 0.070***                        | 0.105***                        |
|                                | (61.1)                          | (113.4)                         |
|                                | PPO*Years in MA since switch    | PPO*Years in MA since switch    |
|                                | 0.004***                        | 0.007***                        |
|                                | (7.0)                           | (12.4)                          |
| **Enrolled in a PFFS plan**    | Enrolled in MA in:              | Enrolled in MA in:              |
|                                | 2009                            | 2011                            |
|                                | 0.042***                        | 0.036***                        |
|                                | (24.7)                          | (7.7)                           |
|                                | 2010                            | 2012                            |
|                                | 0.034***                        | 0.044***                        |
|                                | (21.4)                          | (11.8)                          |
|                                | 2011                            | 2013                            |
|                                | 0.024***                        | 0.077**                         |
|                                | (8.3)                           | (16.7)                          |
|                                | 2012                            | 2014                            |
|                                | 0.018***                        | 0.091**                         |
|                                | (5.3)                           | (15.1)                          |
|                                | PFFS*Years in MA since switch   | PFFS*Years in MA since switch   |
|                                | 0.016***                        | 0.005*                          |
|                                | (10.2)                          | (1.7)                           |
| **Number of Observations**     | 116,101,120                     | 117,611,455                     |
| **R-Squared**                  | 0.668                           | 0.678                           |
| **Individual Fixed Effects**   | Yes                             | Yes                             |
| **Year Fixed Effects**         | Yes                             | Yes                             |

Source: Authors' analysis of Medicare beneficiary summary file and risk adjustment data, 2008 - 2015. T-values in parentheses.

*** p < 0.01; ** p < 0.05; * p < 0.10