Supplemental Materials

Changes in Industry Marketing Payments to Physicians during the COVID-19 pandemic

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**Supplementary figure A.** Flow of study sample selection

1. NPPES Profile Database Allopathic & Osteopathic Physicians (N=1,029,149)
2. Open Payments Profile Database Allopathic & Osteopathic Physicians (N=785,237)
   - Unmatched Allopathic & Osteopathic Physicians (N=97,578)
3. Merged database of NPPES and Open Payments Profile Databases Allopathic & Osteopathic Physicians (N=1,029,149)
   - Allopathic & Osteopathic Physicians outside of US or missing on practice location information (N=148,541)
   - Allopathic & Osteopathic Physicians who received industry payments of >$1 million within a month (N=19)
4. Final database of NPPES and Open Payments Profile Databases Allopathic & Osteopathic Physicians (N=880,589)
**Supplementary figure B.** Monthly trends in the value of industry payments between 2018 and 2020 according to the type of payments.
**Supplementary figure C.** Monthly trends in the number of industry payments between 2018 and 2020 according to the type of payments

**A) Meal**

**B) Travel**

**C) Consulting**

**D) Speaking fee**

**E) Honoraria**

**F) Others**
**Supplementary table A. Test of parallel trend assumption**

| Outcome                        | Interaction term between the monthly trend and the year indicator (i.e., 2019 vs. 2020) |
|--------------------------------|------------------------------------------------------------------------------------------|
|                                | Coefficient estimate [95% CI] | P-value |
| Value of industry payments     | 0.97 (0.95 to 1.00)             | 0.08     |
| Number of industry payments    | 0.946 (0.942 to 0.949)          | <0.05    |

Notes: We used negative binomial regression models with an interaction term between the month trend variable (continuous from December to February) and the year indicator (i.e., 2019 vs. 2020) during the baseline period (December in a prior year to February). Although p-values were small due to the large sample size (~0.9 million), the point estimates were close to 1.0 (i.e., parallel).
**Supplementary table B.** Change in the value of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians’ gender and specialty.

| Physician characteristics | Difference-difference estimates (95% CI) of the value of industry payments per physician | Relative % change | Absolute $ change | p-for-interaction* |
|---------------------------|------------------------------------------------------------------------------------------|------------------|------------------|-------------------|
| **Gender**                |                                                                                         |                  |                  |                   |
| Male                      | -49.5 (-51.6 to -47.3)                                                                   | -96.6 (-103.8 to -89.4) | ref              |                   |
| Female                    | -47.9 (-52.0 to -43.5)                                                                   | -38.0 (-43.3 to -32.7) | 0.14             |                   |
| **Specialty**             |                                                                                         |                  |                  |                   |
| Primary Care              |                                                                                         |                  |                  |                   |
| Internal Medicine         | -45.8 (-52.5 to -38.2)                                                                   | -49.0 (-60.5 to -37.5) | ref              |                   |
| Family Medicine           | -35.3 (-41.8 to -28.0)                                                                   | -11.4 (-15.1 to -7.7) | 0.08             |                   |
| Pediatrics                | -38.0 (-57.6 to -9.4)                                                                   | -8.9 (-15.0 to -2.8)  | 0.58             |                   |
| Hospitalist               | -61.4 (-73.7 to -43.6)                                                                   | -19.3 (-27.3 to -11.3) | 0.29             |                   |
| Surgery                   |                                                                                         |                  |                  |                   |
| Obstetrics/Gynecology     | -51.1 (-60.3 to -39.6)                                                                   | -35.6 (-51.5 to -19.7) | 0.43             |                   |
| General                   | -54.7 (-59.6 to -49.2)                                                                   | -108.2 (-126.3 to -90.1) | 0.03             |                   |
| Orthopedic                | -52.3 (-56.1 to -48.1)                                                                   | -224.5 (-258.5 to -190.5) | 0.12             |                   |
| Otolaryngology            | -55.5 (-65.2 to -42.9)                                                                   | -56.6 (-75.7 to -37.4) | 0.95             |                   |
| Urology                   | -63.6 (-69.9 to -55.9)                                                                   | -163.8 (-202.9 to -124.6) | 0.001           |                   |
| Neurosurgery              | -51.3 (-61.3 to -38.7)                                                                   | -205.5 (-284.3 to -126.6) | 0.51             |                   |
| Plastic                   | -53.0 (-68.3 to -30.4)                                                                   | -97.7 (-158.8 to -36.5) | 0.52             |                   |
| Thoracic/Vascular         | -49.5 (-58.8 to -38.0)                                                                   | -187.8 (-255.2 to -120.5) | 0.60             |                   |
| Colorectal                | -62.2 (-72.3 to -48.4)                                                                   | -180.0 (-257.6 to -102.4) | 0.12             |                   |
| Specialists               |                                                                                         |                  |                  |                   |
| Emergency Medicine        | -51.1 (-63.8 to -34.0)                                                                   | -24.8 (-37.3 to -12.4) | 0.58             |                   |
| Psychiatry                | -72.2 (-76.0 to -67.7)                                                                   | -126.1 (-146.4 to -105.7) | <0.001          |                   |
| Anesthesiology            | -46.9 (-56.5 to -35.2)                                                                   | -22.0 (-32.0 to -12.1)  | 0.58             |                   |
| Radiology                 | -18.5 (-32.7 to -1.4)                                                                   | -21.1 (-40.3 to -1.8)  | 0.01             |                   |
| Cardiology                | -48.8 (-53.9 to -43.2)                                                                   | -165.8 (-192.7 to -138.9) | 0.43             |                   |
| Ophthalmology             | -58.5 (-64.6 to -51.5)                                                                   | -139.2 (-168.8 to -109.7) | 0.06             |                   |
| Pediatric Specialty       | -55.2 (-66.9 to -39.2)                                                                   | -63.6 (-94.5 to -32.7) | 0.34             |                   |
| Neurology                 | -69.5 (-72.4 to -66.3)                                                                   | -489.8 (-547.2 to -432.5) | <0.001          |                   |
| Rehabilitation            | -59.3 (-68.2 to -47.9)                                                                   | -50.7 (-72.1 to -29.2)  | 0.06             |                   |
| Dermatology               | -50.0 (-55.5 to -43.8)                                                                   | -196.0 (-241.7 to -150.4) | 0.29             |                   |
| Gastroenterology          | -57.5 (-63.3 to -50.8)                                                                   | -109.5 (-135.8 to -83.3) | 0.03             |                   |
| Hematology/Oncology       | -37.8 (-46.8 to -27.3)                                                                   | -195.1 (-260.6 to -129.6) | 0.55             |                   |
| Nephrology                | -48.1 (-61.8 to -29.5)                                                                   | -79.3 (-114 to -44.6)  | 0.51             |                   |
| Pulmonology               | -55.5 (-64.0 to -45.0)                                                                   | -155.9 (-201.7 to -110.1) | 0.12             |                   |
| Infectious Diseases       | -63.0 (-70.9 to -55.0)                                                                   | -222.7 (-275.7 to -169.7) | 0.01             |                   |
| Endocrinology             | -45.6 (-51.4 to -39.0)                                                                   | -271.5 (-345.0 to -198.0) | 0.79             |                   |
| Rheumatology              | -62.6 (-67.2 to -57.4)                                                                   | -483.8 (-574.1 to -393.5) | <0.001          |                   |
| Allergy/Immunology        | -38.8 (-53.2 to -20.0)                                                                   | -98.8 (-185.2 to -12.5)  | 0.51             |                   |
| Others                    | -20.1 (-36.0 to -0.1)                                                                   | -18.1 (-39.1 to -2.9)   | <0.001           |                   |

*P-value (adjusted for multiple comparisons using the Benjamini-Hochberg method) of the multiplicative 3-way interaction term between i) the year indicator (i.e., 2019 vs. 2020), ii) the month indicator (i.e., January-February vs. April-December), and iii) gender or specialty.
**Supplementary table C.** Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the four regions in the US.

| Type of payments | Difference-in-difference estimates (95% CI) of the value of industry payments per physician | Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians |
|------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
|                  | Relative % change | Absolute $ change | Adjusted p-value | Relative % change | Absolute change | Adjusted p-value |
| Total            | -48.4 (-50.6 to -46.2) | -75.7 (-81.2 to -70.3) | <0.001 | -47.4 (-47.7 to -47.1) | -43.6 (-44.2 to -43.0) | <0.001 |
| Northeast        | -47.0 (-51.4 to -42.2) | -68.4 (-77.9 to -59.0) | <0.001 | -51.7 (-52.4 to -51.0) | -40.2 (-41.4 to -39.0) | <0.001 |
| Midwest          | -51.9 (-54.6 to -49.0) | -83.9 (-92.3 to -75.4) | <0.001 | -42.4 (-43.0 to -41.9) | -47.7 (-48.9 to -46.6) | <0.001 |
| South            | -47.5 (-52.0 to -42.6) | -72.9 (-85.0 to -60.8) | <0.001 | -46.9 (-47.7 to -46.1) | -35.9 (-37.2 to -34.7) | <0.001 |
| West             | -44.2 (-52.1 to -34.9) | -49.8 (-68.2 to -31.4) | <0.001 | -42.6 (-44.2 to -40.9) | -43.1 (-46.0 to -40.2) | <0.001 |

Four regions (Northeast, Midwest, South, and West) were defined according to the Census Bureau. Difference-in-difference estimates in relative percentage changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable negative binomial models adjusting for physicians’ gender, specialty, and practice location. The adjusted absolute changes in outcomes were estimated by calculating the differences in predicted outcomes at each level of the interaction terms for each observation and averaging over the entire sample. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.
**Supplementary table D.** Change in the number of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians’ gender and specialty.

| Physician characteristics | Difference-difference estimates (95% CI) of the number of industry payments per 100 physicians | Relative % change | Absolute change | p-for-interactiona |
|---------------------------|-------------------------------------------------------------------------------------------------|-------------------|-----------------|-------------------|
| **Gender**                |                                                                                                 |                   |                 |                   |
| Male                      | -47.3 (-47.7 to -46.9)                                                                         | -49.7 (-50.5 to -48.8) | ref             |                   |
| Female                    | -47.9 (-48.5 to -47.2)                                                                         | -31.5 (-32.3 to -30.6) | 0.30            |                   |
| **Specialty**             |                                                                                                 |                   |                 |                   |
| Primary Care              |                                                                                                 |                   |                 |                   |
| Internal Medicine         | -38 (-38.9 to -37.2)                                                                           | -35.1 (-36.6 to -33.7) | ref             |                   |
| Family Medicine           | -20.6 (-21.6 to -19.6)                                                                         | -8.9 (-10.2 to -7.5) | <0.001          |                   |
| Pediatrics                | -54.6 (-56.1 to -53.0)                                                                         | -16.7 (-17.6 to -15.8) | <0.001          |                   |
| Hospitalist               | -56.2 (-59.8 to -52.3)                                                                         | -20.5 (-23.3 to -17.6) | <0.001          |                   |
| Surgery                   |                                                                                                 |                   |                 |                   |
| Obstetrics/Gynecology     | -53.1 (-54.4 to -51.7)                                                                         | -29.1 (-30.8 to -27.4) | <0.001          |                   |
| General                   | -66.0 (-67.2 to -64.8)                                                                         | -48.5 (-50.8 to -46.2) | <0.001          |                   |
| Orthopedic                | -62.8 (-64.0 to -61.5)                                                                         | -60.6 (-63.8 to -57.4) | <0.001          |                   |
| Otolaryngology            | -64.9 (-66.7 to -62.9)                                                                         | -39.9 (-42.9 to -37.0) | <0.001          |                   |
| Urology                   | -56.6 (-58.1 to -55.1)                                                                         | -82.1 (-87.1 to -77.0) | <0.001          |                   |
| Neurosurgery              | -58.8 (-61.5 to -55.9)                                                                         | -63.8 (-70.9 to -56.7) | <0.001          |                   |
| Plastic                   | -66.1 (-68.9 to -63.1)                                                                         | -48.6 (-54.2 to -42.9) | <0.001          |                   |
| Thoracic/Vascular         | -61.4 (-64.4 to -58.1)                                                                         | -71.6 (-80.9 to -62.3) | <0.001          |                   |
| Colorectal                | -66.2 (-70 to -61.9)                                                                           | -57.4 (-69.3 to -45.4) | <0.001          |                   |
| Specialists               |                                                                                                 |                   |                 |                   |
| Emergency Medicine        | -46.3 (-48.8 to -43.8)                                                                         | -11.9 (-13.3 to -10.5) | <0.001          |                   |
| Psychiatry                | -57.6 (-59.0 to -56.2)                                                                         | -59.2 (-62.5 to -55.9) | <0.001          |                   |
| Anesthesiology            | -46.8 (-49.0 to -44.4)                                                                         | -16.8 (-18.5 to -15.2) | <0.001          |                   |
| Radiology                 | -59.0 (-61.7 to -56.0)                                                                         | -17.7 (-19.6 to -15.9) | <0.001          |                   |
| Cardiology                | -51.5 (-52.5 to -50.4)                                                                         | -106.2 (-111.1 to -101.4) | <0.001          |                   |
| Ophthalmology             | -52.7 (-54.3 to -51.0)                                                                         | -45.2 (-47.9 to -42.5) | <0.001          |                   |
| Pediatric Specialty       | -63.3 (-66.2 to -60.1)                                                                         | -20.1 (-22.6 to -17.5) | <0.001          |                   |
| Neurology                 | -51.1 (-52.6 to -49.5)                                                                         | -147.3 (-156.4 to -138.1) | <0.001          |                   |
| Rehabilitation            | -38.4 (-41.8 to -34.8)                                                                         | -23.2 (-27.3 to -19.0) | 0.95            |                   |
| Dermatology               | -47.9 (-49.3 to -46.3)                                                                         | -101.2 (-107.5 to -94.9) | <0.001          |                   |
| Gastroenterology          | -57.1 (-58.4 to -55.8)                                                                         | -112.1 (-117.5 to -106.7) | <0.001          |                   |
| Hematology/Oncology       | -60.2 (-61.8 to -58.6)                                                                         | -128.7 (-136.5 to -120.9) | <0.001          |                   |
| Nephrology                | -63.7 (-65.6 to -61.6)                                                                         | -71.9 (-77.4 to -66.4) | <0.001          |                   |
| Pulmonology               | -39.5 (-41.7 to -37.1)                                                                         | -56.1 (-64.1 to -48.0) | 0.48            |                   |
| Infectious Diseases       | -63.7 (-66.3 to -60.8)                                                                         | -78.5 (-87.6 to -69.4) | <0.001          |                   |
| Endocrinology             | -41.8 (-44.3 to -39.3)                                                                         | -113.9 (-128.3 to -99.4) | <0.001          |                   |
| Rheumatology              | -55.9 (-57.8 to -53.9)                                                                         | -241.9 (-262 to -221.8) | <0.001          |                   |
| Allergy/Immunology        | -24.6 (-27.9 to -21.2)                                                                         | -21.5 (-32.1 to -10.8) | <0.001          |                   |
| Others                    | -44.1 (-46.8 to -41.3)                                                                         | -17.8 (-19.6 to -16.1) | <0.001          |                   |

aP-value (adjusted for multiple comparisons using the Benjamini-Hochberg method) of the multiplicative 3-way interaction term between i) the year indicator (i.e., 2019 vs. 2020), ii) the month indicator (i.e., January-February vs. April-December), and iii) gender or specialty.
### Supplementary table E. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to the average outcomes in 2018 and 2019 according to the type of payments.

| Type of payments | Difference-in-difference estimates (95% CI) of the value of industry payments per physician | Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians |
|------------------|---------------------------------|---------------------------------|
|                  | Relative % change | Absolute $ change | Adjusted p-value | Relative % change | Absolute change | Adjusted p-value |
| Total            | -49.2 (-51.1 to -47.3) | -77.0 (-81.6 to -72.4) | <0.001 | -47.9 (-48.2 to -47.6) | -44.6 (-45.1 to -44.0) | <0.001 |
| Meal             | -64.0 (-64.3 to -63.7) | -14.9 (-15.1 to -14.8) | <0.001 | -46.5 (-46.8 to -46.2) | -37.8 (-38.3 to -37.4) | <0.001 |
| Travel           | -93.9 (-94.3 to -93.4) | -19.1 (-20.0 to -18.3) | <0.001 | -91.3 (-91.8 to -90.9) | -5.8 (-6.0 to -5.6) | <0.001 |
| Consulting       | -18.3 (-25.0 to -11.1) | -8.0 (-11.3 to -4.6) | <0.001 | +1.6 (-2.2 to +5.6) | ±0.0 (±0.0 to +0.1) | 0.50 |
| Speaking fee     | -36.9 (-41.1 to -32.4) | -13.3 (-15.4 to -11.3) | <0.001 | -34.8 (-37.0 to -32.5) | -0.9 (-0.9 to -0.8) | <0.001 |
| Honoraria        | -51.8 (-57.8 to -44.9) | -2.5 (-3.0 to -2.0) | <0.001 | -5.5 (-27.6 to +23.3) | ±0.0 (±0.0 to ±0.0) | 0.68 |
| Others           | -17.1 (-32.3 to +1.5) | -1.4 (-2.8 to ±0.0) | 0.07 | -34.6 (-36.9 to -32.2) | -0.3 (-0.4 to -0.2) | <0.001 |

Difference-in-difference estimates in relative percentage changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2018/2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable negative binomial models adjusting for physicians’ gender, specialty, and practice location. The adjusted absolute changes in outcomes were estimated by calculating the differences in predicted outcomes at each level of the interaction terms for each observation and averaging over the entire sample. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.
**Supplementary table F.** Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the type of payments using ordinary least squares regression models.

| Type of payments | Difference-in-difference estimates (95% CI) of the value ($) of industry payments per physician | Adjusted p-value | Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians | Adjusted p-value |
|------------------|---------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------|------------------|
| Total            | -82.2 (-86.2 to -78.2)                                        | <0.001           | -41.7 (-42.3 to -41.1)                                                                          | <0.001           |
| Meal             | -14.1 (-14.3 to -13.9)                                        | <0.001           | -34.9 (-35.4 to -34.4)                                                                          | <0.001           |
| Travel           | -17.2 (-17.8 to -16.5)                                        | <0.001           | -5.9 (-6.0 to -5.7)                                                                            | <0.001           |
| Consulting       | -6.9 (-9.6 to -4.2)                                            | <0.001           | +0.1 (+0.0 to +0.1)                                                                           | 0.02             |
| Speaking fee     | -39.6 (-41.7 to -37.4)                                        | <0.001           | -1.0 (-1.1 to -0.9)                                                                           | <0.001           |
| Honoraria        | -2.3 (-2.9 to -1.8)                                            | <0.001           | ±0.0 (-0.1 to +0.1)                                                                            | 0.83             |
| Others           | -2.2 (-3.1 to -1.2)                                            | <0.001           | -0.1 (-0.1 to ±0.0)                                                                           | 0.13             |

Difference-in-difference estimates in absolute changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable ordinary least squares regression models adjusting for physicians’ gender, specialty, and practice location. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.